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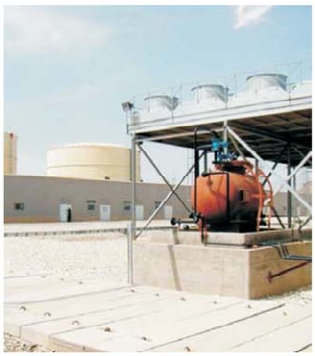
Kajaki Dam Unit 2 Hydro Inventory and Condition Assessment Report – FINAL
January 31, 2012



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AMENDED 5 FEBRUARY 2014

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Appendices

List of Acronyms

AAR ..... Approved As Revised

ASME ..... American Society of Mechanical Engineers

BVSPC..... Black & Veatch Special Projects Corp.

CCN ..... Cooperating Country National

CMIC ..... China Machine-Building International Corporation

DABS ..... Da Afghanistan Breshna Sherkat (National Electrical Utility)

DoD ..... Department of Defense

DOE ..... Department of Energy

FIO ..... For Information Only

GFE..... Government Furnished Equipment

GSU ..... Generator Step-up

HPP ..... Hydro Power Plant

IED..... Improvised Explosive Device

JV ..... Joint Venture

KHPP ..... Kandahar Helmand Power Project

LBG..... Louis Berger Group

MWH..... Montgomery, Watson and Harza

O&M ..... Operations & Maintenance

ODC..... Other Direct Costs

OEM ..... Original Equipment Manufacturer

PA's ..... Plant Arrangement

PLC ..... Programmable Logic Controllers

PMO ..... Program Management Office

PSD..... Protective Service Detail

SCADA ..... Supervisory Control and Data Acquisition

TCN ..... Third Country Nationals

USAID ..... United States Agency of International Development

Executive Summary

The Black & Veatch Special Projects Corp. (KHPP) deliverable under Subcomponent 6.1 Kajaki Hydro Power Plant (HPP) in Helmand Province, Afghanistan is as follows (Please reference page 38 and 39 of the US Agency for International Development (USAID)-KHPP Base Contract):

Subcomponent 1: Inventory Assessment of Government Furnished Equipment (GFE)

The inventory and condition assessment was performed in two phases due to unavailability of material handling equipment required to access much of the equipment and materials stored in shipping containers. USAID was informed of the constraint and directed that KHPP proceed with an initial assessment until such time as the material handling equipment could be made available. The initial assessment was performed January 11 – February 16, 2011 and represented approximately thirty percent of the total assessment required. A draft inventory and condition assessment report was submitted to USAID on February 16, 2011. Following repair of the onsite material handling equipment and certification consistent with USAID KHPP contractual requirements, a second assessment was performed July 18-August 21, 2011. The balance of the inventory and condition assessment was incorporated into a draft Final Report submitted to USAID on August 29, 2011.

USAID provided review comments on the draft final report in October 2011. KHPP responded to comments and reviewed the report and comments with USAID during a meeting in Kandahar on November 17, 2011. Comments and complete responses are included in Appendix 23. A Final report, issued January 31, 2012, incorporated those comments and included revised schedule and cost estimates, dated November 11, 2011.

Between August and December 2013 USAID requested that a Joint Inventory be performed by KHPP, Da Afghanistan Breshna Sherkat (DABS), and USAID staff and that a Unit 2 GFE joint final inventory be developed. This task was completed with an agreed Joint Inventory which is provided in Appendix 11 & 12 Joint Inventory. Since the Final Report was issued in January 2012, KHPP advanced the plant design, prepared a Unit 2 Installation subcontract tender package, and procured selected GFE long lead time replacement equipment. USAID provided additional comments on the Final Report in January 2014. This Amended Final Report is an updated report which incorporates KHPP's response to the latest USAID comments, long lead time items which have been procured by KHPP, and relevant design advancements.

This report presents the findings of the inventory and condition assessment of GFE at the Kajaki HHP for Unit 2 and electrical and control upgrades to Units 1 and 3. In the process of performing the scope of work applicable to Component 6, KHPP has determined additional upgrades to Units 1 and 3 which could significantly improve the reliability and generating capacity of Kajaki HPP. Although out of the scope of required assessment, these improvements were a logical fall out of work within scope and are described in Section 5 of this report for USAID consideration. In addition, as required by the scope of work assigned, a Materials Transportation Plan, Level 2 schedule and preliminary cost estimate are also presented.

Site Assessment Activities

Site assessment activities are summarized as follows:

First GFE assessment (January 11 to February 16, 2011):

- The KHPP Hydro Assessment Team mobilized January 16, 2011. It was planned that the team complete work and demobilize February 5, 2011. Due to inclement weather, which grounded required helicopter transportation, the team did not demobilize until February 16, 2011.
- Security handover from LBG's subcontractor Hart Security to KHPP's security subcontractor ISS-Safenet was not finalized until June 2011 due to changes in Afghan government regulations concerning private security contractors.
- Multiple challenges were encountered in undertaking the first assessment, including:
    - Obtaining material handling equipment. The existing mobile crane and fork lift on site were not operational. Repair parts were ordered, but the mobile crane could not be repaired before the site assessment team left site in February. Approximately thirty percent of all GFE was reconciled to available inventory listings. Inspections of material could not be performed due to lack of material handling equipment. Inventory assessment was also hampered by lack of detailed shipping, inventory, and packing documentation. Proper dry storage facilities for sensitive equipment did not exist on site. The team secured this type of inventoried material for medium/long term storage in the reconstituted Kajaki storage warehouse (warehouse required extensive repair).
    - Highway 611 was not open and all materials and tools (including mechanic and crane repair parts) required to support the assessment had to be flown in by helicopter.
    - Adequate reference material, (shipping and packing lists, complete drawings, and detail bills of quantity) which was to be provided by the Government per contract, was not provided.
- A preliminary list of required replacement parts based on the accessibility to equipment was compiled when the initial assessment was completed and included in the draft report (Section 8 of the initial draft report dated 16 February 2011).
- In the initial assessment, KHPP recommended that the GFE inventory 13.8 kV switchgear be replaced as they were deemed not safe for the intended purpose. Upon acceptance of this report, KHPP will pursue USAID consent to proceed with procurement.

Second GFE Assessment Activities (July 18 to August 28, 2011)

- The KHPP Hydro Assessment Team remobilized July 18, 2011 and completed the assessment and providing report input on August 28, 2011.
- During the assessment, the fork lift required for material movement for inspection failed. A Bobcat/fork lift and operator were provided by local US Marine contingent, which allowed the assessment to continue per adjusted schedule.
- During the inspection process, all materials and equipment were rearranged onsite and their locations mapped for future reference. The electrical apparatus was double covered and left in the "warehouse" for safe keeping until needed for installation. The non-electrical GFE was re-crated and placed back into a container if it could be potentially damaged by exposure to the elements. If the equipment was intended for outdoor use anyway, it was left in the Laydown Yard with a tarpaulin for protection. Some sensitive material would not fit into a container or the "warehouse" and was therefore double covered with visqueen plastic sheeting and a new tarpaulin. The cable reels were stored along the gravel road beyond the camp towards the powerhouse.
- A comprehensive description of each container or package was documented using the GFE inventory Excel spreadsheet format utilized for the initial GFE assessment.
- Of the 386 individual items (crates, packages, and loose equipment) identified in the original GFE provided inventory list provided by USAID, 30 were not located on site or were duplicate entries. In addition, 45 additional items were located and identified, which were not identified in the original GFE inventory list.

Third GFE Assessment Activities (August to December 2013)

- Between August and December 2013 USAID requested that a Joint Inventory be performed by KHPP, DABS and USAID staff and that a Unit 2 GFE Inventory agreed final inventory be developed. This task was completed with an agreed Joint Inventory which is provided in Appendix 11 & 12 Joint Inventory.

<u>Findings and Recommendations-Unit 2 and Unit 1 and 3 control upgrades</u>

Major findings are summarized below. A detailed list of Assessment Recommendations for Unit 2 and Units 1 and 3 upgrades is presented in Appendix 20.

1. The majority of GFE has been assessed as useable, given its condition (with reasonable refurbishment).
2. The 13.8 kV switchgear needs to be replaced (not safe for purpose).

3. The SCADA / PLC control system must be configured and a comprehensive factory test performed in a controlled environment (off-site) to ensure the integrated PLC application software and SCADA supervisory software is in compliance with specifications and performance requirements. This will minimize disruptions and the time involved during the controls conversion and start-up of each operating Unit.

4. An analysis of Unit 1 and Unit 3 field devices should be undertaken with the goal of modifying / replacing field devices that are compatible with the controls architecture of Unit 2 – implementation of Option A. (See Section 4.3.11 of this report)

5. Ongoing line fault and plant trip issues identified in the Kajaki Hydro Plant Transmission and Distribution Facility Assessment Report cannot be resolved at the power plant only. Final design of plant equipment related to the fault resolution issue must be coordinated with design of the new Kajaki substation. New arc-resistant switchgear to replace existing GFE switchgear will be procured with additional circuit breakers to isolate the power plant from the13.8 kV local distribution system to address this issue from the plant side. Final plant protection must still be coordinated with design of the new Kajaki substation. (See section 4.3.8 of this report.)

6. A number of parts, such as generator stator bars and generator thrust bearing insulation, require replacement due to damage. Complete findings are presented in Section 4 of this report.

7. Some parts or materials, such as rusted air, water, and oil piping, were deemed more cost effective to replace than to clean to levels required.

8. Some parts or materials, such as some electrical cable whose condition could not be verified or tested until installation, were identified to be replaced. These represented significant schedule risk if they were found to need replacement during construction.

9. Unit 2 Inlet Valve cracks were found, as identified by USAID, but are not structural in nature and can be repaired on site.

10. All exposed metal surfaces will require cleaning and refinishing.

11. Repair the Kajaki Power Inlet Gate to allow the powerhouse penstock to be dewatered such that the Unit 2 penstock can be tied into the existing penstock manifold.

Findings and Recommendations – Units 1 and 3 Additional Upgrades (Out of Scope)

The assessment identified issues associated with Units 1 and 3, which are outside the current scope of the identified electrical and control upgrades to Units 1 and 3. Major findings are summarized below. A detailed description of additional upgrades to Units 1 and 3 is presented in Appendix 16 and a detailed list of the upgrades is presented in Appendix 17.

1. Rewind Units 1 and 3 generators.
2. Rehabilitate or replace Units 1 and 3 governors including all new hydraulic elements and sub-systems.
3. Replace Units 1 and 3 excitation systems with solid state excitation similar to Unit 2.
4. Improve the existing oil handling facilities inside the plant.
5. Improve Kajaki HPP black start capability, including replacing the existing micro-hydro unit.

Materials Transportation Plan

A Materials Transportation Plan is being developed at the project level to support camp development, operation and construction at the Kajaki site for the duration of the project. A specific Material Transportation Plan for the hydro plant work (Component 6) outlining number and type of trucks and mobile equipment is described in Section 6. Timing and grouping of material and equipment transportation for Component 6 will be integrated into and coordinated with the broader project level transportation plan. The Materials Transportation Plan is a dynamic document, which will continue to evolve as the overall project definition evolves. The version attached to this report was current at the time of the Final Report preparation and forms the basis of schedule and cost estimate in this report.

Schedule

The conceptual Level 2 schedule and Basis of Schedule for all known items related to installation, testing, and commissioning of the Kajaki Unit 2 hydroelectric turbine generator and all known related scope necessary to enable operational capability of Unit 2 are described in Section 8 and the conceptual Level 2 schedule is shown in Appendix 21. Work includes repairs/improvements to Units 1 and 3 as required to facilitate proper interface between Units 1, 2 and 3 of the Kajaki HPP and camp upgrades/repairs required to support the staff necessary to complete the Unit 2 works. The estimate and schedule is based on total project duration of 34 months from Notice to Proceed for Subcomponents 6.2 and 6.3 with construction duration of 22 months.

Note: The original Kandahar Helmand Power Project scope for BVSPC included both the hydro plant installation and the new Kajaki substation. The schedule and cost estimate for the hydro plant installation presented in this report were based on BVSPC performing both projects. Subsequent to completion of this report, design and construction of the Kajaki substation was assigned to a third party.

The scope and schedule of the substation work has not yet been determined. In addition, another project to upgrade the existing irrigation outlet works at Kajaki HPP was identified to be performed by another party concurrently with the planned Kajaki Unit 2 installation. The schedule presented in this report does not address potential schedule extension to the hydro plant installation schedule due to third party substation and irrigation outlet works construction activities occurring concurrent with the hydro plant installation on the small, congested Kajaki site.

At the time of this Amended Report, the schedule for the third party substation and irrigation outlet works construction activities and coordination of their activities with the hydro installation work was still being negotiated.

Cost Estimate

The preliminary cost estimate to complete Component 6 is provided in Appendix 22. A normalized cost comparison of estimated costs for Unit 2 to similar projects is provided in Section 10.

The Basis of Estimate provides a Basis of the Costs for all known items related to installation, testing and commissioning of the Kajaki Unit 2 and all known related scope necessary to enable operational capability of Unit 2 is described in Section 9. Work includes repairs/improvements to Units 1 and 3 identified in the contract scope as required to facilitate proper interface between Units 1, 2 and 3 of the Kajaki HPP and camp upgrades/repairs required to support the staff necessary to complete the Unit 2 works. The known work has been identified in the assessment report. The estimate includes the cost only for those GFE items identified for repair/replacement in the assessment report.

Note: Similar to the schedule, the cost estimate presented in this report does not address potential cost increases to the hydro plant installation cost due to third party substation and irrigation outlet works construction activities occurring concurrent with the hydro plant installation on the small, congested Kajaki site.

Cost Comparison

A cost comparison of estimated costs for Unit 2 to similar projects is presented in Section 10.

Major Assumptions

Major assumptions used in developing the project cost estimate and schedule include the following:

1. Highway 611 will be open and secure continuously for an agreed amount of time before site construction begins.
2. Cost based on assumed conditions in the region**.**

Next Step

COMPONENT 6.1-Perform inventory assessment of GFE

As a precursor to approval by USAID to proceed with a) the Repair or procurement of missing or additional GFE equipment and b) the Install and Commission of Unit 2, KHPP was required to conduct an on-site audit and prepare this assessment report as per Subcomponent 6.1.

This assessment report contains recommendations for both the repair of GFE equipment and provision of missing, damaged and additional new equipment required for completing the installation of Unit 2 and upgrades to Units 1 and 3 identified in the original project scope. USAID review comments and KHPP detailed responses are contained in Appendix 23.The Final Report incorporated USAID review comments and included revised schedule and cost estimate from those presented in the Draft Final Report. USAID approved the Final Report in January 2012.

Between August and December 2013 USAID requested that a Joint Inventory be performed by KHPP, DABS and USAID staff and that a Unit 2 GFE joint final inventory be developed. This task was completed with an agreed Joint Inventory which is provided in Appendix 11 & 12 Joint Inventory. Since the Final Report was issued in January 2012, KHPP advanced the plant design, prepared a Unit 2 Installation subcontract tender package, and procured selected GFE long lead time replacement equipment. USAID provided additional comments on the Final Report in January 2014. This Amended Final Report is an updated report which incorporates KHPP's response to the USAID's comments, long lead time items which have been procured by KHPP, and relevant design advancement.

SUBCOMPONENT 6.2

It was agreed by USAID and BVSPC that the Cost for this work could not be accurately determined at the time of execution of the original contract agreement. USAID provided a placeholder budget number of [redacted] million for this work. No actual repair or provision of missing and additional new equipment will take place until specific approval by USAID is given for the recommendations in the Final Assessment report. KHPP will then submit a Request for Consent to proceed under this Subcomponent. Until such time as the draft GFE report is accepted as final and USAID provides notice of acceptance, KHPP will cease all work other than security and maintenance of the Kajaki HPP camp and on site GFE. KHPP will continue to provide on call technical assistance to the Kajaki HPP as necessary. In January 2012, USAID approved the Final Report and authorized KHPP to proceed with Subcomponents 6.2 and 6.3.

Subsequent to the issue of the Final Report in January 2012, USAID authorized KHPP to proceed with procurement of long lead time GFE replacement equipment and materials. KHPP procured and delivered to Kajaki HPP selected long lead time GFE replacement equipment. The supply of other GFE long lead time equipment was incorporated into the scope of the Kajaki Unit 2 Installation subcontract.

SUBCOMPONENT 6.3

It was also agreed by USAID and BVSPC that the Cost for the installation and commissioning of Unit 2 could not be accurately determined at the time of execution of the original contract agreement. USAID provided a placeholder budget number of [redacted] million for this work. Upon receipt of USAID Consent to proceed, KHPP will prepare and send out bid packages to subcontractors for construction scope. In January 2012, USAID approved the Final Report and authorized KHPP to proceed with Subcomponents 6.2 and 6.3.

Beginning in January 2012, proceeded with Subcomponent 6.3. KHPP prepared the Kajaki Unit 2 Installation subcontract package, which included supply of selected GFE long lead time replacement equipment, tendered the package, received and evaluated bids and finally submitted Request for Consent for this package in August 2012. In January 2013 USAID issued a Partial Suspension of Work to KHPP. USAID ultimately transferred the responsibility for completing the Kajaki HPP project from KHPP to the Government of the Islamic Republic of Afghanistan (GIRoA) and DABS.

SUBCOMPONENT 6.4

In December 2013 USAID issued a contract modification to KHPP directing KHPP to provide construction technical support services as requested by USAID to support the completion of Kajaki Unit 2 by DABS.

Introduction

Black & Veatch Special Projects Corp. (KHPP) has been requested to conduct an inventory and condition assessment of Government Furnished Equipment (GFE) at the Kajaki Hydro Power Plant (Kajaki HPP) in Helmand Province, Afghanistan. This assessment is one subcomponent of the Kandahar Helmand Power Project.

The inventory and condition assessment was performed in two phases due to unavailability of material handling equipment required to access much of the equipment and materials stored in shipping containers. The initial assessment was performed January 11 – February 16, 2011 and represented approximately thirty percent of the total assessment required. Following repair of the onsite material handling equipment, the assessment team returned July 18-August 21, 2011, to perform a second assessment.. The completed GFE inventory and condition assessment was incorporated into the original Final Report, dated 31 January 2012.

Between September and December 2013, DABS, KHPP and USAID performed a joint inventory of all Unit 2 equipment and materials in preparation for turnover of all equipment and materials to DABS. Unit 2 equipment and materials included all original GFE for Unit2 and the Unit 1 and 3 control system upgrades plus new equipment procured by KHPP to replace damaged GFE. As requested by USAID, this Amended Final Report is an update to the original Final Report. It incorporates the new KHPP procured equipment, relevant design advancement by KHPP from January 2012 through December 2013, and the finding s of the joint final inventory.

Kajaki Hydro Power Plant

1.0 OBJECTIVE

The objective of the Kajaki Hydro Inventory and Condition Assessment Report is to assess the condition of the existing Government Furnished Equipment (GFE) before proceeding with the balance of the work associated with the installation of Unit 2, upgrades to Unit 1 and 3 switchgear, controls, metering, and protection. Before a complete proposal could be prepared for what is essentially a turn-key approach to the Kajaki HPP, a detailed inventory and thorough condition assessment of the GFE equipment currently being stored at the Kajaki site was necessary to determine the condition of the GFE, determine the extent of repair and/or replacement which may be required, and determine what may be missing and require replacement.

The Final Report, issued January 31, 2012,was prepared as Deliverable 4-Final Assessment Report for Subcomponent 6-1: Inventory Assessment of GFE identified in the Prime Contract Section F.4.A: Deliverables. This report also again addresses in Section 7.4 the preliminary assessment of potential long lead time items and serves as the Deliverable 2. Subsequently, USAID requested that the assessment report be updated to incorporate the new KHPP procured GFE long lead time replacement equipment, relevant design advancement by KHPP from January 2012 through December 2013, and the finding s of the joint final inventory. This Amended Final Report is prepared in response to that request.

The report is organized into the following sections:

1.0 Objective

2.0 Background: Provides background to the project

3.0 Inventory and Condition Assessment Approach: Describes the approach to the assessment task, including the assessment team, inspection and testing equipment, and constraints to a more expedient and efficient completion of the assessment

4.0 Inventory of Materials and Equipment: Describes the condition of the storage area as found at beginning of assessment, maps of the post assessment storage yard and warehouse, and detail findings and recommendations

5.0 Repair Units 1 and 3 Analysis and Recommendations – Additional Upgrades for Units 1 and 3 (Out-of-Scope): Presents the assessment of Unit 1 and 3 operation and recommendations for additional repairs to improve long term operation and reliability of Units 1 and 3

6.0 Materials Transportation Plan: This section describes the materials transportation plan which will quantify equipment and materials shipments to the Kajaki site

7.0 Summary: Summarizes equipment requiring replacement or repair and long lead time items

8.0 Schedule: Presents preliminary Level 2 schedule for project execution

9.0 Major Cost Estimate Components: Presents preliminary cost estimate for the current scope of installation of Unit 2 and Units 1 and 3 original scoped controls upgrades

10.0 HPP Cost Comparisons: Presents a comparison of estimated costs for Kajaki Unit 2 work to similar projects.

2.0 BACKGROUND

In 1975, USAID installed and commissioned two 16.5 MW hydroelectric turbine generating units in the Kajaki Hydro Power Plant (HPP). The powerhouse was designed as a three unit plant with installation of Units 1 and 3 (16.5 MW each) and a vacant unimproved "skeleton" bay for the future erection of Unit 2. USAID has completed the rehabilitation of the Units 1 and 3 in 2009 with the exception of controls, switchgear, metering, and protection.

A contract was awarded to China Machine-Building International Corporation (CMIC), in January 2005, for the design, manufacturing and erection of an 18.5 MW hydroelectric turbine generator to be installed as Unit 2 at Kajaki Powerhouse. The CMIC contract also included supply and installation of remaining control, switchgear, metering, and protection systems for Units 1 and 3 not provided with the unit rehabilitation. Further, the CMIC contract also included supply and installation of certain upgrade and replacement of power house common equipment, required because of additional power output of the station with the installation of Unit 2. The components were manufactured by various manufacturers and delivered by CMIC to Afghanistan.

Delivery of components began in the summer of 2006 and ended in March 2009. Delivery was difficult due to the non permissive environment created by anti government elements along the transportation route. Some components were airlifted to the site; many of the large components were delivered by a military supported convoy in September 2008. Due to lack of warehouse space at Kajaki HPP, the Unit 2 components as well as other CMIC equipment supply are in storage under tarpaulins and inside shipping containers. These have been stored this way since their delivery. Initial site preparation and civil work for the installation of Unit 2 started March 2008 with a small construction crew from CMIC. In November 2008 CMIC employees withdrew from the Kajaki work site due to security concerns, without performing any significant work.

"All components of the Unit 2 turbine generator installation, upgrades for Units 1 and 3, common equipment upgrades, improvements to Tangi substation, and spare parts are now believed to be onsite" (per RFP). Limited inventory of this equipment has been made by others and was provided to the Contractor as Government Furnished Equipment (GFE) Inventory List. The delivery of aggregate, cement and reinforcing steel needed for erection of the turbine generator Unit 2 must be arranged by the Contractor.

In December 2010, US Agency for International Development (USAID) awarded a contract to Black & Veatch Special Projects Division (Contractor) to execute the Kandahar Helmand Power Project (KHPP). One component of the project (Component 6) is to install and commission Kajaki Unit 2.

The Statement of Work in the contract clearly identifies the need to assess the condition of the existing Government Furnished Equipment (GFE) before proceeding with the balance of the work associated with the installation of Unit 2 and upgrades to Unit 1 and 3 switchgear, controls, metering, and protection. However, before a complete proposal can be prepared for what is essentially a turn-key approach to the Kajaki HPP, the detailed inventory and thorough condition assessment of the GFE

equipment currently being stored at the Kajaki site was necessary to (1) determine the condition of the GFE, (2) determine the extent of repair and/or replacement which may be required, and (3) determine what may be missing and require replacement. There is also a small amount of GFE equipment for Kajaki HPP stored in Kabul. The equipment stored in Kabul was later moved to the KHPP Laydown Yard in Kandahar and subsequently transported to Kajaki HPP.

The condition assessment of Tangi substation related GFE equipment noted by the hydro site assessment team, including the 13.8/20 kV transformer, will be reported in the separate *Kajaki Hydro Power Plant Transmission and Distribution Facility Assessment Report Draft*. The substation report, dated March 17, 2011, is presented in Appendix 1.

3.0 INVENTORY AND CONDITION ASSESSMENT APPROACH

3.1 Overview

The original intent of the inventory and condition assessment of GFE was to review existing Government Furnished documents on the plant design and equipment supplied under the CMIC contract, perform an on-site inventory and condition assessment, and prepare a draft inventory and assessment report for USAID review and approval. A draft Inventory and Condition Assessment Plan describing the proposed plan for the inventory and assessment was approved by USAID on January 11, 2011.

Based on USAID's approval of the Inventory and Condition Assessment report findings, Contractor would then prepare a proposal for performing the installation and commissioning of Unit 2 and the upgrades to Unit 1 and 3 switchgear, controls, metering, and protection. However, due to constraints described in the next section, the onsite inventory and condition assessment could not be completed as originally intended.

The scope of the Final Inventory and Condition Assessment Report was to:

- Provide an inventory of existing GFE and materials at site.
- Identify needed repairs to existing equipment.
- Identify what existing equipment must be replaced with new equipment.
- Identify what equipment and materials are missing and must be replaced.
- Provide an estimated timeline for repairs and new equipment and materials (batching plant, cement, sand) delivery.
- Inspect quarry and aggregate crushing facility to determine if it is still fit for purpose.
- Include test reports for testing performed.
- Inspect crane on site to determine all requirements for repair.
- Identify procedures to prevent deterioration of GFE and keep in readiness for installation.

Subsequently, USAID requested that the assessment report be updated to incorporate the new KHPP procured GFE long lead time replacement equipment, relevant design advancement by KHPP from January 2012 through December 2013, and the finding s of the joint final inventory. This Amended Final Report is prepared in response to that request.3.2 Hydro Site Assessment Team (HSAT)

A very experienced, multi-disciplined team of hydropower engineers performed the site assessment. This team of experts was supported by a staff of personnel to perform detailed inventory of materials and to open and re-package the existing storage containers. During the initial site assessment in January-February, the hydro assessment team coordinated its activities with the Power Delivery team which was assessing the condition of the existing Kajaki and Tangi substations. A separate substation assessment report was filed.

The HSAT consisted of the following:

John Marks	KHP Generation Manager, B&V
George Redd	Team Leader, Hydro Electrical Engineer, B&V
Tom Spicher	Hydro Mechanical Engineer, B&V
Richard Taylor	Instrumentation/Control Engineer, B&V
Maurice Wheat	Civil Engineer, B&V

A local crane mechanic was also brought to site to assess the condition of the mobile crane and fork lift which were on site but not operable.

The team was flown into the Kajaki site on January 14, 2011. The team was scheduled to spend three weeks onsite and leave the site on February 5, 2011. Due to adverse weather conditions which prevented helicopter flights, part of the team did not leave the Kajaki site until February 14. The balance of the team left Kajaki site February 16.

Immediately following repair and certification of the mobile crane and forklift onsite, per USAID contract requirements, the HSAT returned to Kajaki on July 18, 2011.

The second assessment team consisted of the following:

John Marks	KHP Generation Manager, B&V
George Redd	Team Leader, Hydro Electrical Engineer, B&V
Chris Marlatt	Site Liaison, B&V
Xiansheng Chen	Electrical Engineer, B&V (onsite two weeks)
Maurice Wheat	Civil Engineer, B&V

The assessment team completed the inventory and assessment tasks on August 21, 2011. The team remained onsite to continue documentation of its findings, mapping the rearranged storage areas, properly covering stored equipment, and contributing to this report. The team left Kajaki on August 28, 2011. Progress of the team throughout its activity was hampered by the extremely hot, ambient temperatures (generally in excess of 105 degrees F in shade)

3.2 Inspection and Testing Equipment

In preparation for the site assessment, a preliminary list of tools and equipment were identified. This list was also coordinated with the Power Delivery assessment team and their requirements to assure adequate resources for the work without unnecessary duplication.

The preliminary list of inspection and testing tools and equipment consisted of the following and were either available on site or carried in by the assessment team except as noted:

- Megger, 1 kV
- Pressure gage for X/F gas blanket (if not on each X/F already)
- Dew Point Meter (if X/F's are gas blanketed)
- Fluke Multi-Meter

- Inspection light (primarily for X/F internal inspection)
- Flashlights
- Camera
- Tarps and rope to protect equipment not already adequately stored—(Note: amount of material which could be brought into site by the team on their helicopter was very limited.)
- Hand tools and tools for uncrating parts
- Torque wrench
- Micrometer set
- All-terrain forklift of sufficient capacity for parts that require relocating—(Note: forklift on site was not operable until it was repaired by the team on site)
- Crane for moving/relocating large parts (largest single items-stator-29,200 kg, transformers 28,960 kg, generator shaft 11,467 kg, pole assembly cases 8,900 kg, others 4,500 kg or less) – (Note: mobile crane on site was not operable until repaired by the team on site)
- Fluke Model 725-US Multi-function instrument calibrator
- Fluke Model C25 carrying case
- Fluke Model TLK-200 Accessory Kit
- Fluke Model TPAK80-4 ToolPak Strap & Magnet Hangers)
- Borescope
- Pallet jack
- Satellite phones –Two
- Sampling bottles –for oil and water sampling

3.3 Constraints

The following issues prevented KHPP from completing the inventory and condition assessment by the original planned schedule.

3.3.1 Material Handling Equipment

Initial Assessment

The containers were originally stacked tightly together due to the limited space on site to spread things out. In order to move containers, a mobile crane with appropriate rigging was required to lower the stacked containers to the ground where they could be opened and contents accessed. A mobile crane would also be required to restack the containers after the inventory and assessment work is complete. A forklift is required to access individual boxes, crates, etc. inside the containers. See photographs of the storage yard as found at the site in Appendix 2. The arrangement of the Laydown Yard as found is further described in Section 4.1 of this report.

The most efficient process for performing the inventory and condition assessment was to have both the crane and forklift serviced and repaired such that they are both operational before the assessment team arrived for the initial assessment. KHPP had made preliminary inquiries into the condition of the mobile crane and forklift. KHPP understood that neither the crane nor the forklift was operational and that neither the mobile crane nor forklift would be available for the initial site assessment. The crane was in need of repair. The forklift required new batteries and other unknown repairs. Equally important was

assuring appropriate rigging, including a pallet jack, was on site when the assessment was to begin. Without adequate access to the containers and their contents, the assessment team could not complete its task during the initial assessment. USAID was informed and made the decision that KHPP should proceed to perform as much of the GFE assessment as possible without the proper equipment.

Given that the crane and forklift were not operational during the initial site assessment, the site assessment team endeavored to evaluate the condition of the mobile crane and forklift and determine what parts and repairs would be required to make them operational. A local crane mechanic was brought on site to evaluate the crane and forklift. Status of the mobile crane and forklift as of February 14, 2011 was as follows:

- Mobile Crane—the crane is a 1970's vintage crane. It is rated at 75 tons. No manuals or documentation were present on site and none were available from the original manufacturer due to its age. The mechanic evaluated the crane's condition and prepared a list of replacement parts required. Parts were then procured in Kabul. When parts were obtained, the crane was repaired and tested on site. A new replacement mobile crane should be considered when Highway 611 to Kajaki HPP is opened and secured. The crane is required not only near term for accessing equipment and materials in the yard, but also long term for future plan construction.
- Forklift—the forklift was also inspected. The forklift needed replacement batteries, which were ordered and shipped to Kajaki HPP. The master brake cylinder also needed replacement. A replacement was found in Kabul and was sent to the site. The forklift was required not only near term for accessing equipment and materials in the yard, but also long term for the future plant construction.

The team inspected and inventoried as much as they could get to within the three week window on site during the initial assessment. It is estimated that only about one-third of all GFE could be reconciled to the inventory listings. However, information gained by the partial inventory and condition assessment, which was performed without benefit of the crane or forklift, was useful in gaining a general understanding of the storage conditions and site conditions. But the information was incomplete due to KHPP's inability to adequately access stacked containers and much of contents in the bottom containers. A return trip was required by the site assessment team after the crane and forklift were repaired, serviced and made operational and appropriate rigging was on site.

KHPP had reasonable expectations that contents of containers and individual packages could be identified from available documentation. Although the Government provided its interim GFE inventory list, the Government provided the list with the proviso that the list was FIO (For Contractor's Information Only). While the GFE inventory list generally identified what crates, boxes, etc. should be in each container, the list did not identify which containers are on the ground and which are stacked in the top row. Therefore, Contractor could not determine which containers he would be able to enter in advance of arrival on site. Nor was the GFE inventory list current. The site assessment team learned that the shipping containers had been unloaded and repackaged several times such that the GFE

inventory list became simply a list of items to be located, rather than a map of what and where items were.

Second Assessment

When the second assessment began, the mobile crane and forklift were operational. The mobile crane remained operational throughout the assessment period. However, the mobile crane's usefulness was limited because it could not access the interior of the containers or the storage warehouse. The forklift broke down on August 5 and could not be repaired until August 16. The assessment was only able to continue progress due to the cooperation of the local US Marine forces who made their bobcat equipped with fork attachments and an operator available to the assessment team when the Marines did not need it.

Joint Inventory

In 2013 KHPP performed upgrades to the camp facilities at Kajaki site. These upgrades included refurbishing the warehouse and rearranging the GFE laydown yard. All lifting equipment required for moving GFE around and putting it into its current location in the warehouse or laydown yard was provided.

3.3.2 Reference Documents

Prior to the site assessment, KHPP reviewed the following Government Furnished Information (GFI):

1. Equipment shop drawings. These are in individual folders identified by the Tech Spec Section (02 TM-1 Turbine). These drawings have been prepared and submitted by CMIC or their sub supplier under the original equipment contract. They have been reviewed by MWH and are generally noted Approved or Approved as Revised.

2. Plant Drawings (PA's). These drawings are noted For Tender Only, not for construction.

3. Inventory of GFE. The list of 386 packages. (See Appendix 3)

4. LBG-CMIC Contract, dated 26 January 2005. (Complete contract document.)

5. List of Contract Drawings. A list of drawings in Item 2 above.

6. List of Manufacturers. Not clear, but it appears this was a list of acceptable suppliers for the major components, not list of actual suppliers.

7. Listing of FIO Government Furnished Drawings. List of the shop drawings for each component in Item 1 above.

8. Previous Contract Specs. Technical specifications.

9. Previous Contract's Bill of Quantities.

10. Technical Data Sheets. Equipment data sheets from original CMIC proposal.

While helpful for background and/or for downstream design, the Government Furnished Information did not provide information which was very helpful to the initial site assessment. To facilitate KHPP's onsite efforts, KHPP sorted the GFE inventory list by container and storage area (see Appendix 4). However, in order to efficiently perform the Inventory and Condition Assessment, KHPP requested additional documents. The Government, in its review comments to the Draft Inventory and Condition Assessment Plan, dated January 11, 2011, responded to this request. The requested documents and the Government's response are listed below:

- Individual Packing Lists for each "package" identified in the Inventory of GFE document provided. The GFE Inventory document lists 386 discrete packages (crates, bundles, etc.). It also generally identifies by name what each package is. What KHPP was looking for were packing lists which itemize the contents of each package. When requested, the following response was received:

  Response: The Government is not aware of itemized lists for the 386 discrete packages.

  KHPP Note. The assessment team did find some packages with individual packing lists attached or inside. However, some of the packing lists had deteriorated and/or faded due to sun exposure and moisture to the point of not being legible. This issue is described in more detail in Section 4.2 of this report.

- Packaging, Transportation, and Storage Instructions from manufacturers. There does not seem to be any of this type of information in the GFI provided. This would have given KHPP insight into what should have been done, allowed KHPP to compare what was done to what should have been done, and help determine what should be done in the future to protect the equipment. When requested, the following response was received:

  Response: The Government is not aware of any information on this from manufacturers.

  KHPP Note: The assessment team did find a few crates, primarily electrical gear, with packaging and storage instructions attached.

- Factory Test Reports, if there are any. These would describe what factory testing was done prior to shipping and insight into the condition of the equipment at the time of shipping. When requested, the following response was received:

  Response: The Government is not aware of any of these reports.

  KHPP Note: The assessment team did not find any Factory Test Reports.

- O&M Manuals. There are some O&M sections in the files provided but not discrete O&M manuals where one would expect it all to be assembled. When requested, the following response was received:

  Response: The Government is not aware of any manuals.

  USAID had been told by LBG/B&V JV that there is a room on the second floor of the Kajaki Camp Office with documents from the Chinese Contractors who were on site under the CMIC contract. USAID has not been in the room and has no knowledge of its contents. USAID encourages the assessment team to inspect the room's contents.

  KHPP Note: The assessment team did inspect the room's contents. Very few documents were there. Engineer Rasoul, the Plant Manager, told the assessment team that all CMIC contract related documents had been removed from the site by LBG JV personnel and taken to Kabul. KHPP pursued all documentation, which the LBG JV had available, and received additional documents found up through June 2011. Follow-up contact by KHPP with LBG did not result in any new information.

  The assessment team did find a few crates in the yard, primarily electrical gear, with packaging and storage instructions attached.

  Reviewing available Installation and Operating and Maintenance Manuals from CMIC on GFE equipment, KHPP compiled a list of manuals which one would expect to have been provided with the equipment and compared it to available CMIC manuals. The resulting list indicating which manuals are available and which are not is presented in Appendix 8A.

Of the crates which KHPP could access and open, some had the above information attached or inside them; some did not. Generally, those crates which did have packing lists and other documentation were crates containing equipment. Crates of parts or materials, such as cable, did not have individual packing lists. Without individual packing lists and packing, transportation and storage instructions from manufacturer/supplier, it was impossible to efficiently perform the initial inventory and condition assessment task and complete it in the allotted three weeks on site.

To complete the assessment without such documents, the assessment team needed to visually identify components and determine whether everything is there. If crates had not been opened, it would be reasonable to expect nothing has been taken. However, without packing lists, it will require each package to be individually unpacked and counted and then compared against shop drawings to verify that all the pieces, which were supposed to be present were, in fact, present.

KHPP reviewed documents in the camp Headquarters building. Very little of use was found. It appears the room was set up to accumulate data as the plant rehabilitation progressed. All documents found were associated with the Units 1 and 3 turbine rebuild. No documents regarding Unit 2 were found other than the FIO drawings previously supplied by the Government to KHPP.

Although some additional documents from the CMIC contract were found by KHPP prior to the second assessment, they were of very limited use as they contained no new packing lists, shipping and storage information, or O&M manuals. Given the five week window to complete the second assessment, the assessment team endeavored to inventory individual crates of parts and material to the degree practical without detailed packing lists.

3.3.3 Design Drawings

In the contract, the Government stated that the following documents were available upon request to KHPP for Unit 2.

i. LBG Subcontract Number REFS 02-05-GG451 AR-001 with CMIC. (KHPP has this-see Item 4 in Paragraph 3.4.2 above)

ii. Partial Inventory of GFE and materials. (KHPP has this)

iii. Government Furnished Designs and Schematics that are provided for information only. It is noted that these documents comprise only a partial installation design. (KHPP has these)

In order for BVSPC to perform its forthcoming design effort, the following documents are required from the Government:

- Electrical and I&C design drawings of Units 1 and 3

USAID Response: Other than the design drawings indicated in this item, are there design drawings required for installation of Unit 2 that are missing?

KHPP Note: Given the Government does not have any "new GFE designs," KHPP feels that it has all the available drawings to allow us to complete the design of Unit 2 and Unit 1 and 3 upgrades, including the procurement of replacement equipment. Final design will require shop drawings from the new replacement equipment. The available documents in their current condition are not complete design packages and would not support completion of the project without further engineering effort.

Note: Final electrical and control design for Unit 2 and Units 1 and 3 upgrades require coordination with the Kajaki substation design related to the local distribution interface and ongoing fault trip issues.

- Shop drawings of Units 1 and 3 governor and excitation systems and electrical and I&C equipment (much, if not all, of which will be replaced)

USAID Response: Other than the shop drawings indicated in the second bullet on page 17, are there shop drawings required for installation of Unit 2 that are missing? We're unsure if the text on page

17 and in your email refers only to shop drawings referenced in the second bullet, or to additional shop drawings – and if the latter, what are they?

KHPP Note: KHPP does not have shop drawings on the original Unit 1 and 3 governor and excitation systems and I&C equipment. KHPP does have the original design drawings for Units 1 & 3 prepared by International Engineering Company, Inc. and Fishbach Oman International in 1973-1977. KHPP also has the CMIC design documents for the Units 1 and 3 upgrades described in the KHPP contract documents. However, as noted in the report, many of these drawings are stamped Approved As Revised with comments and questions which required further action or resolution with CMIC which was not done. Therefore, additional engineering will be required to complete the design.

Specifically, the controls system GFE appears to have been shipped without approved shop drawings and the computer control narrative and correspondence indicates that the computer control/monitoring system was not completed nor shipped to site. There is no indication of computer equipment in the GFE Inventory list, nor was it located on site.

- Government Furnished Designs and Schematics for Unit 2

USAID Response: No specific USAID response for this item.

KHPP Note: Given the Government has no additional designs and schematics, KHPP believes we have adequate information to complete the design and schematics required for Unit 2 installation. This will include resolution of review comments on CMIC design and shop drawings.

- All CMIC structural design analysis and calculations

USAID Response: No specific USAID response for this item.

KHPP Note: KHPP is still in need of this information. KHPP has the CMIC design drawings. The CMIC drawings provide plan and sections of the Stage 2 concrete design with reinforcing steel layout and details. However, no CMIC design calculations have been provided. Some static equipment weights are shown on CMIC equipment shop drawings but no operating loads are shown and no design calculations showing how these loads were applied have been provided. Without any calculations or documentation to review, KHPP will need to conservatively redo the structural design to validate what was done. Further, the original Unit 1 and 3 drawings show all of the structural components, including beams and columns, in plan and section. However, the drawings do not appear to show or call out reinforcing steel or show rebar details. These would need to be reviewed to analyze the power house structure and transmission line anchors for the replacement lines going to the rebuilt Kajaki substation.

Lacking CMIC design calculations, KHPP did analyze the Stage 2 concrete design shown in CMIC's drawings by reviewing the equipment static loads and comparing the design to KHPP designs of similar size units. Operating loads were estimated and applied to the Stage 2 concrete. KHPP

revised the layout of suspended slabs at the Turbine Floor and Operating Floor to improve access to equipment for operation and maintenance. The KHPP structural design drawings included in the KHPP Kajaki Unit 2 Installation package reflect this analysis and design. The ultimate contractor for the Unit 2 installation will be the Engineer of Record and should replicate KHPP's analysis and provide his own final design.

Following is a summary of the design documents KHPP has related to Kajaki HPP:

1. Original Unit 1 and 3 drawings. (1973-1977) The status of the drawings varies. Some are noted in the revision block As-Built (mostly electrical). Some are issued for Approval, some are Issued for Construction. KHPP has them on a series of 30 CD's. Attached index matches index of drawings for Kajaki HPP in the file: Afghanistan Energy Information Center (AEIC)/Energy Center Library/AEIC Drawings Collection/AEIC As Builts. However, KHPP could not access the actual files in the AEIC library. Although the file indicates As Built drawings, the drawings KHPP has are not all as built. List of Government furnished drawings are contained in Appendix 5. The original list of Government Furnished drawings has been supplemented by a list of Units 1 and 3 drawings obtained on 30 CD's .

2. FIO Government Furnished Drawings from RFP (CMIC Shop Design and equipment shop drawings-2005-2006). These drawings include CMIC design and equipment shop drawings. As noted in the report, many of these drawings had MWH AAP (Approved As Revised) stamps and MWH comments with no closure from CMIC. So comments will require detailed engineering to review the designs and comments, and determine how to revise or finish the design. An example is CMIC Drawing KAJK-PH-01-E, Powerhouse Section through Unit 2, noted AAR. See Appendix 6. This drawing has open review comments relating to electrical and structural issues. Approximately 27% of all CMIC shop drawings are notes AAR or Not Approved. See Appendix 7 for CMIC drawing list and review status.

3. Miscellaneous CMIC files. John Marks obtained a box of miscellaneous CMIC project files in April 2011. These were scanned and forwarded to Kansas City electronically. These files were a random group of files, ranging from contract specifications and drawings to daily menus on site. Many files were in Chinese. No new design information was identified. List of files attached in Appendix 8. A List of available CMIC equipment is Appendix 8A.

4. Plant Drawings (PA's). These drawings are noted For Tender Only, not for construction.

5. Inventory of GFE. The list of 386 packages. This GFE list included items for the Tangi substation in addition to items for Unit 2 and Units 1 and 3 control system upgrades.

6. LBG-CMIC Contract, dated 26 January 2005. (Complete contract document)

7. List of Manufacturers. Not clear but it appears this was a list of acceptable suppliers for the major components, not list of actual suppliers.

8. Previous Contract Specs. Technical specifications.

9. Previous Contract's Bill of Quantities. CMIC Bill of Quantities – Summary BOQ at equipment level. No detail breakdown or construction commodity BOQ.

10. Technical Data Sheets. Equipment data sheets from original CMIC proposal.

A review of the available shop drawings provided as FOI indicates that several issues were identified in Montgomery, Watson and Harza's (MWH's) review of CMIC shop drawings where the drawings are noted as Approved As Revised (AAR). In some cases, the AAR drawings indicate questions or resolution required by CMIC. No follow-up responses appear to have been made by CMIC.

Specifically, the controls system GFE appears to have been shipped without approved shop drawings and the computer control narrative and correspondence indicates that the computer control/monitoring system was not completed nor shipped to the site. There is no indication of computer equipment in the GFE Inventory list, nor was it located on site.

It is noted that Contract section GS-2.7, Government Furnished Designs and Schematics requires in part that "The engineering drawings, design data, calculations, shop drawings, and submittals of the previous subcontractor (CMIC) are supplied in their current "as-is" state of completion as "For Information Only (FOI)" documents. The submittals are in various state of approval. Any FIO document stamped approved shall have no standing under this contract. All submittals required under this solicitation must be submitted as new for approval."

4.0 INVENTORY OF MATERIALS AND EQUIPMENT

4.1 Overview of Storage Conditions

Kabul

Four items, which were originally stored at the Kabul warehouse, were subsequently moved to the KHPP Laydown Yard in Kandahar and then moved to the Kajaki HPP. The assessment described herein was performed at the Kabul warehouse. A generator shaft and a 25 MVA single-phase transformer were stored outside. A control panel and a box of thrust bearing shoes were stored inside the warehouse. The equipment did not appear to be damaged or deteriorated due to its storage environment. There was damage to the crate housing the generator shaft, but it appeared to be shipment damage and not caused while in storage. There is no material handling equipment at the warehouse, which would allow detailed inspection.

A detailed description of the equipment follows:

One (1) transformer by Fuzhou Tianyu Electric Co. Ltd.

Mfg. January 2007; Serial No. GA 4303

Type DF-9 25,000/63.51 single ϕ rated 25,000kva, 50 Hz, voltage 63.51±4x2.5%/13.8

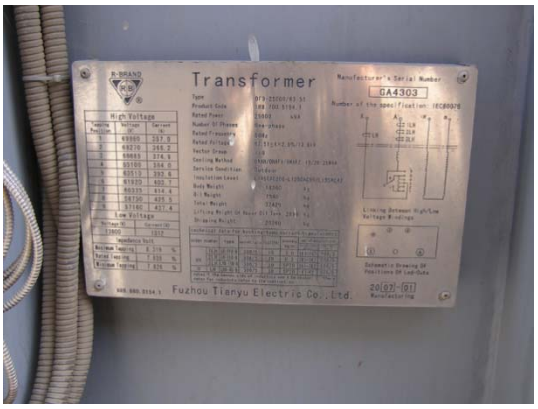
Body wt 18360 kg

Oil wt 7540 kg

Ship wt 28,260 kg

One (1) Set of thrust shoes for Unit 1 or 3, drilled and grooved for high pressure oil lift, well protected with cosmoline and cloth, stored on edge but low total weight and size and very sturdy construction, concave saddle for support pin (believed to be spare shoes for Unit 1 or 3).

One (1) Control cabinet 1600 A LV Panel, no apparent external damage



Transformer Nameplate

Control Panel

One (1) Generator Shaft, totally enclosed for shipping. It is believed one of the support saddles partially collapsed during shipping or handling. A replacement shaft is on site at Kajaki HPP. Inspection of that shaft indicated it matches the mating portions of the unit, either the generator/turbine coupling or the runner/turbine shaft.

The generator shaft at warehouse #2 in Kabul was inspected on Saturday January 22, 2011. It had outside storage and all layers of packing were very dusty. The lower I beam supports were bent during the lifting with insufficient spread between the two pick points. The shaft was level and was checked for end to end variation with a laser level. No deviation was found to the extent that a scale could be read on the center of the laser beam. Balance for the forged and turned shaft are not anticipated to be a concern. The concern would be for the fit to the spider and turbine shaft. A fitted turbine shaft for the new generator shaft was also supplied. The cylindrical keys which match the turbine shaft coupling are noted in the photo below. No match marks were found with about 300° of the coupling inspected.

End of Generator Shaft showing rounded keyways.

The full shaft is painted with a thin black film, probably to be removed upon installation. The lower bearing journal is painted with a red paint. Since most of the damage seemed to be to the crate packing, and no paint damage was noted on the shaft, it is anticipated that there is no concern about use of this shaft.

Lower Guide Bearing journal stove pipe.

Note the red paint on the lower guide bearing journal stove pipe. Both journals had some grey material, probably a rust preventative applied.

The support saddles were quite close to the shaft ends and those saddles showed signs of impact or other stress. The central portion of the shaft near the pick points is considerably larger in diameter. When this shaft is delivered to the project, it should be brought directly to the plant to be unloaded and installed on the new mounting flange atop the U-1 and 3 flange. Drawing KAJK-PH-07-D describes the rotation process required.

The following two photos show the damage to the support beams for the crate. It should be possible to reuse this arrangement to transport to the plant but one or two additional saddles should be installed on the central portion of the shaft. At the time of saddle installation, with a crane lifting one end, further inspection may be obtained of the covered portion of the shaft. If it is determined that the existing saddles require further support, or additional lateral support is needed at the bottom of the crate, that should be added at that time.

Damaged lateral support beams at the largest shaft diameter.

Kajaki Laydown Yard

Background

The assessment team was given to understand that the GFE inventory was shipped to Kajaki camp from various locations. These locations included KAF, Durai Junction, Kabul, and another site. The material was delivered to site via MI-26 Helicopter and British Army convoy in 2008.

The assessment team has received additional information about the shipping and storage of the GFE material. Some of the shipping containers that arrived in Kabul were damaged in shipment from Karachi, Pakistan. Prior to reshipment from Kabul, material stored in the damaged containers was repackaged into other containers.

The repackaging in Kabul resulted in container manifests differing from the shipment arriving in Kabul. For example, the GFE shipping manifests may have indicated a particular crate was stored in container 10, whereas after repackaging the same crate was stored in container 13.

LBG inventoried the repackaged equipment in Kabul. The Kabul LBG container list (in general) matched the Kajaki Site inventory list conducted by LGB in 2010. The discrepancies between the LGB Kabul inventory and the LGB Kajaki site inventory consist (for the most part) of a few boxes per container. However, some containers had large discrepancies in the container's contents.

The assessment team was given to believe that (yet) another repackaging of material occurred after transport from Kabul, but prior to final delivery to the Kajaki site. Material that was a candidate for air shipment to Kajaki via MI-26 helicopter may have been repackaged (again) prior to air transport. It is believed this second repackaging may have occurred at several staging locations prior to arrival in Kajaki.

Finally, identification of wooden shipping crates exposed to sustained direct sunlight has severely impacted identification due to the faded crate identification markings.

Pre-Assessment Conditions

Material in the Laydown Yard is stored in three fashions: 1) Crated and inside shipping containers, 2) Crated and tarped out in the open, and 3) loose, uncrated, and semi-tarped out in the open. The tarps were weathered and in many instances torn and/or wind blown off the equipment. The wooden crates are constructed of light weight material and exposure to the elements caused them to deteriorate and become fragile.

Many of the crates stored out in the open contain sensitive and fragile electrical apparatus. Other material is constructed of steel and not subject to major damage due to exposure. The laydown area is unpaved and all material is subject to dust and other airborne debris.

The shipping containers were originally stacked two high in most instances. Of the 18 containers, seven of them were on top. All containers' doors were found closed, but unlocked. Prior to the second

assessment, the containers were unstacked and all containers repositioned to allow unrestricted access to the doors. This work was done with the mobile crane on site after it was successfully repaired and returned to limited service.

The "at large" material had been placed in sequence with no room to maneuver a forklift or other material handling equipment between the items. In many instances, large rocks were used for cribbing under the crates apparently due to the lack of timber on site for cribbing.

Typical "at large" storage of crated and uncrated apparatus

Transformers are contained within armor-plated containers with no access doors.

Access to all crates, containers and all large devices was accomplished by repositioning the material with the use of the mobile crane and a heavy duty forklift. Extraction of the crates from the containers was difficult because the forklift was unable to enter the containers due to its size and in many instances the crates were rotated so the forks could not be inserted under the crates.

Original view of laydown area showing limited space between container ends.

Contents of containers consist of large, unwieldy, heavy crates

Uncrating and Inspection

Each crate either from the containers or in the Laydown Yard, was moved to an inspection area. The non-electrical apparatus was opened and inspected in the Laydown Yard but the electrical apparatus was taken to the temporary "warehouse" for inspection.

The "warehouse" was fashioned from a burned out two-room building measuring approximately 80 ft. x 100 ft. with only the walls left standing. Scaffold piping was installed as rafters and heavy tarpaulins laid over them for roofing.

The electrical apparatus was double covered and left in the "warehouse" for safe keeping until needed for installation. The non-electrical apparatus was re-crated and placed back into a container if it could be potentially damaged by exposure to the elements. If the equipment was intended for outdoor use anyway, it was left in the Laydown Yard with only a tarpaulin for protection. Some sensitive material

would not fit into a container or the "warehouse" and was therefore double covered with visqueen plastic sheeting and a new tarpaulin.

The cable reels were stored along the gravel road beyond camp towards the powerhouse. Some of the steel reels were damaged and the condition of the cable was questionable but not visibly crushed.

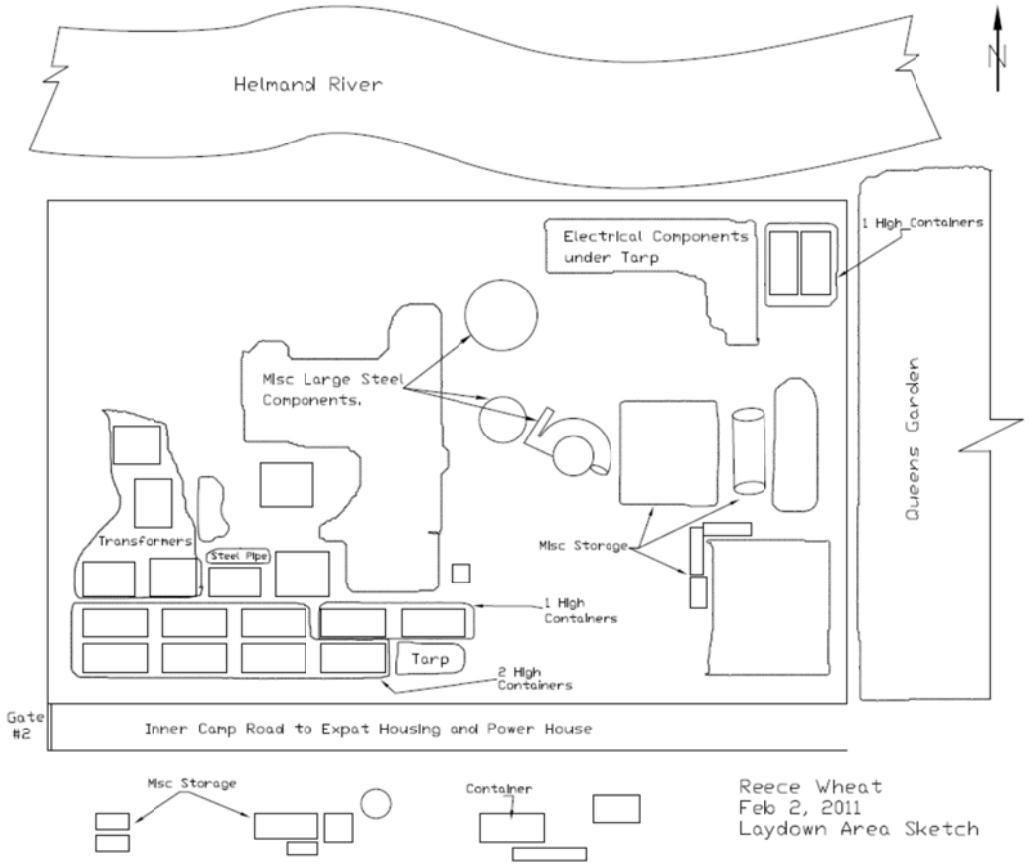
Powerhouse Storage

Twelve crates of GFE were stored inside the Kajaki powerhouse. These crates contained mostly sensitive electrical equipment, such as the governor control panels with their PLC's and circuit breakers for the switchgear. The contents of these crates were generally double sealed and were not opened as the crates were located in damp areas of the plant. A list of items stored in the powerhouse is included in Appendix 9.

4.2 Map of Storage Area (Laydown Yard)

Pre-Assessment Storage Area

The original Laydown area was sketched (see below) to identify where the material was stored when the assessments began.



Sketch of original Laydown area showing container and major under tarp locations for storage.

Post Assessment Storage Areas

The Laydown area was then mapped following the assessment as the North or South Laydown Areas as well as the Warehouse Area to identify where the GFE material is stored. Five (5) maps of the Laydown Areas and the Warehouse Area are in the original Appendix 9.

Photos of Laydown Areas (as found):

Laydown Yard North

Laydown Yard South

Laydown Yard Large Containers – Equipment

Laydown Yard Large Containers – Large Metal Components

Storage Containers in Laydown Yard

Warehouse for Equipment

Cable Reel Storage

The content of each of the 13 containers, which were repacked, was recorded and is provided in the original Appendix 10A final inventory list in the GFE Inventory Excel spreadsheet format was prepared and is provided in the original Appendix 11. This Final Inventory spreadsheet provides detailed

observations for each item identified at site. The detailed information presented in this list provides the basis of findings presented in the following sections.

Of the 386 individual items (crates, packages, loose equipment) identified in the original GFE inventory list provided by USAID, 29 items were not located on site or appeared to be duplicate entries. In addition to the 386 items identified in the original GFE Inventory List, original Appendix 11 also included 53 additional items which were located and inspected but not labeled with a new "Item Number". . The original Appendix 12 provides a tabulation of the original GFE listing annotated to identify missing items, additional items and potentially mis-identified items.

Joint Inventory Assessment Storage Areas

During 2013 KHPP performed several upgrades to the GFE storage areas. The warehouse was refurbished to provide better storage conditions for sensitive GFE and a working area for testing electrical equipment. Warehouse upgrades included a new roof, doors, windows, and lighting and the electrical service was greatly increased. The laydown yard was resurfaced to provide improved drainage and a perimeter security fence was installed to control access to the GFE storage area.

Between September and December 2013, DABS, KHPP, and USAID performed a Joint Inventory of all GFE equipment and materials. As part of this effort, the GFE was unpacked from the containers, examined, repacked into containers, rearranged within the laydown yard and/or moved into the refurbished warehouse. Photos of the final GFE laydown yard are included in Appendix 2A. Updated maps of the final arrangement of GFE following the joint inventory are included in the Amended Appendix 9. This appendix also includes a tabulation of GFE stored in the Kajaki powerhouse. Current contents of the shipping containers in the laydown yard are listed in Amended Appendix 10.

The joint inventory tried to account for all the GFE equipment and materials packages associated with the Unit 2 installation and Units 1 and 3 control system upgrades. Some of the previously "missing" items were found. Other packages were located and identified which had not been previously identified.

At the conclusion of the joint inventory, KHPP staff in conjunction with USAID, updated and integrated original Appendices 11 and 12 into one table and produced a final combined GFE Unit 2 Inventory List which is provided in the Amended Appendix 11 and 12 Joint Inventory. Amended Appendix 11 and 12 has assigned "Item Numbers" to previously unaccounted for or missing items. It also assigned Item Numbers to the BVSPC equipment procured under Clin 6.2 and now considered GFE. The total Amended Appendix 11 and 12 lists a total of 443 items, including 8 items procured under C/S 6.2. This list also includes six items not located and noted missing and 16 items noted as duplicate entry.

Note that Inspection/Inventory Remarks column was not carried over into the Amended Appendix 11 and 12. These comments describing condition and status are shown only in original Appendix 11. Similarly, locations of GFE described in the "New Location" column of the original Appendix 11 is now

out of date. The post Joint Inventory location of GFE is described in Amended Appendix 9 Laydown Yard Maps and Amended Appendix 10 Container Contents.

KHPP has a reasonably high level of confidence that all Unit 2 components required for installation are either on-site or have been identified for replacement. The items which were not specifically located are likely among the "mis-identified" GFE. It remains unclear if the SCADA computers are on site. However, in lieu of detailed packing lists of GFE equipment, in order to assure a complete inventory of all required materials and components, a detailed engineering review of the existing design and preparation of detailed Bills of Materials would be required.

4.3 Details of Findings

The detailed Inventory List in original Appendix 11 prepared by the site assessment team presents the team's findings. Additional judgment was applied to recommend replacement rather than repair for select items where it was deemed to be either more cost effective to replace than refurbish and/or not being able to confirm useable condition of an item until installation, which represents a significant schedule risk. These recommendations are generally indicated in the finding's discussion.

4.3.1 Turbine

Equipment Description

Vertical shaft Francis type hydraulic turbine including spiral case, head cover, guide bearing, and shaft seal.

Bottom Ring

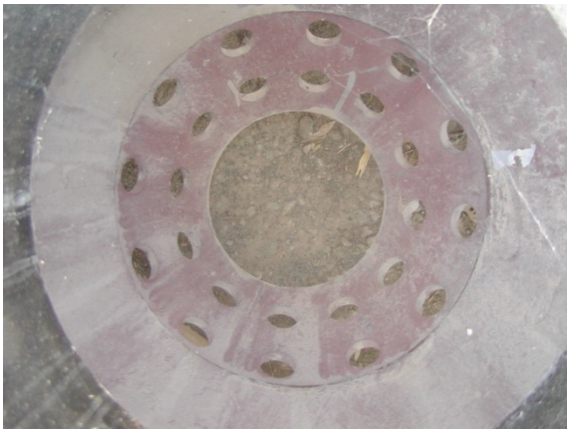
The lower ring of the turbine housing the wicket gates (guide vanes) includes lower bushings and attaches to the bottom of the stay ring. The ring has the wicket gate self-lubrication bushings already installed, however the assembly has been out in the elements for an extended period of time and the bushings are contaminated with dust and dirt. The paint has deteriorated and needs to be repainted. The bushings need to be cleaned and checked for proper operation before installation of the ring.

There were no fitting pins located on site to align the lower ring for proper wicket gate stem fit. These will have to be provided as tools by the erection team.

Lower Ring showing paint deterioration

Runner

The crate for the Unit 2 runner was opened and the runner was examined. It appears to have a reasonable degree of workmanship. The cone is fixed to the crown and is perforated to allow air to vent towards the blade discharge.



Runner Nose Cone vent holes as seen from top.

The runner is a martensitic stainless steel and has some minor areas of corrosion present. There are notations for matching the turbine shaft to the runner. A new turbine shaft was supplied with the new generator shaft. The runner/turbine shaft match is fixed with flat keys at 90°.

View of runner as uncrated

Runner hub showing flat keys at 90°

This runner has 14 blades, an unusual combination for the 24 stay vanes and wicket gates (guide vanes) due to the potential for damaging resonance. The relatively short penstock may accept the vibration without resonance but it is a chancy design gaffe. Other recent installations have also reflected the potential for resonant frequencies without apparent problems.

The problem that may arise with combinations of numbers of runner blades and wicket gates/stay vanes is that the pulsation caused as each blade passes a gate may resonate with other components within the system. For that reason, often runners will have 13, 17 or 19 blades to avoid any resonance. Wicket gate numbers are usually even. Cavitation is not associated with this aspect. The pulsations may interact with the resonance of the rotating system (shaft, runner, rotor), the penstock, the draft tube (casing or flow) or electrical systems (frequency, in-plant systems or down wire ties).

It is possible that the CMIC supplier considered all of these possibilities and found no potential problems. KHPP notes the deviation from long standing practice, not that there was a definitive problem. It is rare for the Chinese to deviate from established practice. Unfortunately, it may take operation to prove out the quality of the installation. Should resonance within the system prove to be a problem, this could definitely present early failures. Some manufacturers have added half blades to the runner to push the impulse frequencies to double their normal. Most hydraulic frequencies are in a very low range, less than 10hz. The rotating system has number of poles, operating frequency (50hz in this case) and resonance of any of the rotating elements that may interact that may be much higher in natural frequencies. The base line frequency of rpm X Blades X gates = 1866.48hz. Not a prime number and certainly in the realm of other component's first or third natural resonant frequency. KHPP only has the government furnished equipment shop drawings. KHPP does not have any detailed design or manufacturing data on the original GFE equipment and doesn't know how far Dong Fang went in their investigation.

Temporary number markings were added with a felt tip marker: Blade 1 at Key 1. Permanent stampings should be added near the lower discharge on the band for future reference on damage monitoring.

Normally Blade 1 is identified at the shaft match mark and numbered in direction of rotation from the underside.

With delivery to Kajaki HPP of the original generator shaft from Kabul, a determination needs to be made on which turbine shaft to use and which one matches the onsite generator shaft. No damage to the original generator shaft was identified by the assessment team. With more ability to adjust alignment, the fit of turbine shaft to the turbine runner is not as critical as the fit of the turbine shaft.

Pressure Relief Valve (Pressure Regulator)

The Relief Valve components are in good condition with no physical damage and with only general deterioration of the paint noted. The martenistic stainless steel valve seat has some observed staining. The slide cylinder will require lubrication upon installation.

The servo operator for this pressure control system is on site and has been identified. The hydraulic control module and connection hose for the valve were damaged in transit or handling and require replacement. The linkage, control rod, and slide rods have been located and are suitable for use.

Inlet end of the valve

Outlet end of the valve

Discharge pipe for pressure relief valve

Pressure Relief Valve operating yoke

Draft Tube

The edges for welding were in good shape with a partial "Vee" shape provided. The flanges are well sized. Supports to maintain shape during shipment were sturdy and well placed. The paint coating has deteriorated.

Draft Tube Sections

The three draft tube sections provided will extend the assembly to the edge of draft tube pit concrete wall where the draft tube discharge splits into two channels through the concrete to the tailrace. There are no steel plate sections on site to transition to the concrete if the bare concrete is to be used as the discharge channel or to line the concrete if that is the intent of the design.

Spiral Case and Head Cover

The balance of the spiral case and the take-off for the pressure reducing valve completes the spiral case enclosure. All large pieces of the scroll case were braced for shipment and handling with temporarily

welded in steel cross members. All of these seem to have helped maintain the geometry of the large shapes. All edges are well prepared for welding after positioning and prior to embedment.

Inspection and testing of the turbine head cover bolts was identified as an inspection scope item in the original scope of work. As presented in the draft Unit 2 Hydro Inventory and Condition Assessment Plan, KHPP recommended that it would be more cost effective to simply replace the entire set of bolts than to inspect, test, and still replace the bolts, which would be destructively tested. USAID approved that recommendation in their January 11, 2011, comments to the draft report. Visual inspection of the bolts, described in Appendix 13, supports that recommendation. The bolts were not located on site during the assessment and will be replaced anyway. The spiral case stay ring is pre-drilled and tapped for the head cover bolts so changing the bolt size cannot be considered an option at this time.

Access to the spiral case was identified in the specification as requiring a 750 X 900 mandoor. The equipment supplied has a 750mm diameter round manhole which emulates the access in the two existing units. Since the rather small diameter spiral case is embedded and the penstock make-up section is exposed, that is where all three units will have the high pressure or supply side access. That pipe would be difficult to provide with the large rectangular mandoor as specified.

The spiral case sections have joints that are chamfered for in-place welding and supports are in place for holding the shape. These sections will require significant modification including machining, tapping, and a full sand blast and recoating after embedment.

The bottom surface of the scroll case which rests on the adjustable embedded sole plates appears to the naked eye to be warped. If this warpage extends to the ring fit for the lower ring, on-site machining may be reqired to properly fit the lower ring or to correct the warped plate prior to embedment.

Spiral Case situated upside down. Note apparent warpage of the top (bottom when in use) plate.

Two-part coal tar epoxy will be used as a coating for the turbine components' "wet" surfaces. Part B is xylene bisophenol A, which has a limited shelf life. This material is used to coat the inside of the water conveyance pieces of the turbine. A 2-part epoxy material has a shelf life of approximately one year

and since it has been in storage for over five years, it should be properly disposed of and replaced. It is anticipated to purchase 65 gallons of replacement 2-part epoxy coal car kits.

Partial Spiral Case

Head Cover with Guide Vane bushings installed

Guide Vanes (Wicket Gates)

Twenty-four guide vanes (wicket gates) are provided. The shipping crate was badly deteriorated but the guide vanes are in satisfactory condition. The combination of 24 guide vanes and 14 runner blades is unusual due to the potential for penstock resonance vibration, but may not be a problem in this application.

Guide Vanes (Wicket Gates), 24 count

Guide Vane Levers (Operating Ring Arms)

Operating Ring

The operating ring is intact with the exception on one damaged anti-friction pad. The pad appears to have caught on some cribbing and torn loose from its mounting screws. The pad seems to be beyond repair and must be replaced. Installation of a new pad is superficial. As can be seen, this component will require clean up and re-painting. The installed self-lubricating bushings will require clean up as well.

Operating Ring with self-lubricating bushings installed.

Damaged anti-friction pad at bottom ring.

Turbine Guide Bearing

The turbine guide bearing housing and six (6)ch guide bearing shoes were located and examined. All components were found to be in good condition. The housing is complete with cooling coil in place and with an installation kit (O-rings, nuts, bolts, Loctite, piping).

Turbine Shaft Seal

A turbine shaft seal housing is provided complete with mounting hardware (O-rings, nuts, bolts, gasket sealant, Loctite). The shaft packing is not in the installation package. Shaft packing was found loose but was badly contaminated with dirt and debris and is unusable. New packing is required. All other shaft seal material and parts are in good condition. An inflatable seal is provided to engage when unit is at a standstill so the main seal can be serviced/replaced without dewatering the turbine.

4.3.2 Governor

Equipment Description

Speed governing equipment for Unit 2 complete with governor oil pumps, pressure tank, sump tank, air compressors, and governor and actuator cubicles. The existing governors at Units 1 and 3 need to be converted to digital control, which will require the supply of necessary software.

Observations

The governor cabinet was uncrated and inspected. All components appeared to be in good condition with no shipment damage observed. However, without a detailed bill of material, KHPP could not confirm that all piping and fittings are on-site. The governor is of the digital design with an electronic speed sensor. The main control valve is digitally controlled with a PLC mounted in the cabinet. Identical controls are provided for the conversion of Units 1 and 3.

The governor electronic components are typically subjected to relatively high temperatures due to the pump being in the same enclosure. High ambient temperatures should not cause an early failure. All of these components are typically backed up with spares due to potential early failure. Specific spare components were not identified on site. Vibration may also have degraded connectors. Solid state devices are usually more secure than earlier types of electrical/electronic switches. No field testing could be performed by the assessment team. This equipment could not be appropriately tested on site without the proper documentation and, in some cases, assembling the related equipment items. Testing will identify pre-existing problems when installed and those components may then be obtained (if not on site) and replaced.

Given that the electronic components could not be tested, the poor storage conditions, and the potential schedule risk of component failure during installation, it is recommended that the electronic components be replaced and appropriate spares be obtained.

The governor servos and linkage to the operating ring were inspected and found to be in satisfactory condition. One of the servos is equipped with a built-in locking device, which is hydraulically controlled to secure the servo position for personnel safety during maintenance.

Pressure Vessel

There is no stamp or other evidence of tank certification for the governor oil cushion tank. The tank should be certified for service. The tank has been exposed to the elements and has deteriorated and will need to be repainted before being placed in service.

Unit 2 Governor Air Receiver (Pressure Tank).

Findings and Recommendations

Prior to installation, the receiver and the oil reservoirs on the governor control cabinet should be internally inspected.

4.3.3 Inlet Valve

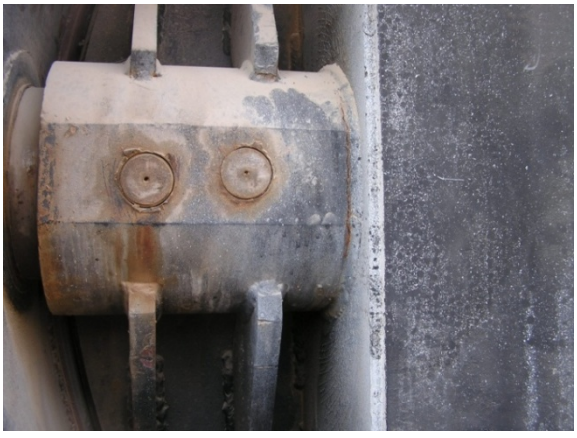
Equipment Description

The inlet valve equipment includes the horizontal shaft butterfly biplane type valve including valve body, disc, shaft, bearings, adjustable seals and bypass assembly.

Observations

Both of the cylinders welded to the gussets have cracks adjacent to the stiffener plate. These are not critical structural connections and can be repaired on site. Cracking was probably due to excess heat applied during construction welding with no provision for thermal contraction during cooling. A field repair should incorporate grinding a "Vee" for the length of the crack and two short weld passes for that length with cooling between passes. Cover passes should duplicate that process until the groove is filled. Emphasis should be on penetration into the cylinder rather than the side gusset plate. The additional ties to the leaf are sufficient to provide support to what is essentially a spacer on the leaf shaft. Cracking was found on both sides as well as the back side of the cylinder shown on the left side. The back side cracking is not accessible for repair.

Upstream view of Inlet Valve



Close-up of left cylinder with crack

Close-up of crack

The make-up section downstream of the inlet valve has a 30-inch access manhole high off the floor that would be a tight squeeze for anyone attempting entry. The specifications call for an entry hatch much larger, but due to the fact that the entry cannot be made through the scroll case, this method was chosen as it matches Units 1 and 3.

The servo for normal opening and closing has been stored loose outside with no protection from weather or physical damage. The servo stem that is exposed outside the cylinder body is badly rusted, but it appears to be in full retraction, therefore not subjecting the shaft seal to abrasion (clean-up only required). The hydraulic control module and the connecting hydraulic hose have been badly damaged and require replacement. All of the hydraulic control valves and electronic components on this module have been damaged.

The main inlet valve counterweight for emergency closure has surface deterioration due to exposure to the elements. This component requires clean up and painting but otherwise appears to be usable.

The motor operator on the motor operated bypass valve and a hand-wheel operated guard valve on the inlet valve by-pass have been damaged and will require replacement. The manual valve stem is bent and the handwheel is broken as well.

Broken motor operator on the Main Inlet Valve bypass

Findings and Recommendations

The inlet valve was found to be in serviceable condition. Shrink cracks were found on the valve stem cylinders but these cracks are in non-critical structural connections and can be repaired on site using proper welding techniques. The valve servo control module has been damaged and needs to be replaced. The bypass motor operated valve and hand wheel operator on a guard valve are broken and must be replaced. The rubber O-rings for the inlet valve were noted to be weather beaten and cracked and must be replaced. Flange bolts, 144 count, for three flange joints are missing and will have to be provided. The inlet valve flanged section is in satisfactory condition except for some minor rust and corrosion. This component will require clean up and paint care at time of erection.

4.3.4 Auxiliary Mechanical Systems

Equipment Description

The auxiliary mechanical systems consist of the embedded and exposed piping and equipment required to support the addition of the third generating unit (Unit 2) into the existing plant.

Observations

Several bundles of various sizes of standard pipe intended for air, water and oil systems are included in mostly exposed racks. This should cause minimal problems because all of the piping that is exposed will require cleaning prior to painting.

Typical assortment of standard and stainless steel pipe.

A lube oil filter press has been provided with the Unit 2 equipment. The filter press is obviously used and definitely of outdated design. Kuno type oil filters are much more efficient in removing water and contaminants from lube oil. The oil supplied with the equipment is transformer insulating oil. There is no lube oil in the GFE at all. It would be prudent to use Type 1 oil in the bearings and governor of Unit 2 since it is used for the other two units. If Type 2 oil is used in Unit 2, it is almost certain that the two types will eventually be intermixed and since they are not compatible, it would be problematic.

Findings and Recommendations

This section includes pipe fittings and miscellaneous material for the governor oil, water, and air piping systems. This material includes flanges, tee sections, gaskets, nuts and bolts, hoses, unions, and couplings. Also included is a tall control panel with pre-engraved front. However, the crate has been heavily damaged by exposure to the weather. From KHPP's field observations, many of the contents are rusty and covered with dust and dirt and rodents have also infested the crate. Overall, the contents appear to be usable but will require general thorough clean-up and reconditioning. It was initially envisioned in the field that the rusted piping will have to be cleaned and painted at assembly. Embedded piping and the servo piping will require internal cleaning. However, due to potential schedule delay during construction and an inability to get replacement components in a timely manner due to the inability to properly recondition these parts, KHPP has assumed to replace these piping systems and miscellaneous other parts. There are assorted Unit 2 cooling water system piping fittings and materials, safety valve, Victaulic couplers, and flanges. The weldable flanges are severely rusted and must be replaced; as the gasket sealing faces are rust pitted and will leak. The flat rubber gasket material has become stiff and deformed and unusable and it must also be replaced.

Type 1 lube oil must not be mixed with Type 2 lube oil. The GFE does not include lube oil, so it is recommended that Type 1 oil be utilized for Unit 2 to avoid inadvertent mixing with the oil presently in use in the plant.

A bladder for lube oil storage is recommended as opposed to barrel storage. Storage of oils in barrels leads to contamination, clutter, and poor housekeeping. Bladder capacity should equal the total maximum oil contained in one unit. It is recommended that the oil always be passed through a Kuno type filter when draining from the system and then again when returning the oil to the unit sumps.

The current estimate in Section 9 includes generally replacing all parts and materials identified for replacement in Section 7.1 with new materials due to schedule risk associated with finding unexpected problems while reconditioning these small items. These systems are not on the schedule critical path. Potential cost reduction for reconditioning these items is estimated to be [redacted].

4.3.5 Generator and Auxilliary Equipment

Equipment Description

Vertical synchronous generator rated 25.4 MVA, 13.8kV, 0.8 pf, 50 Hz, 333.3 rpm, Class F insulation.

Observations

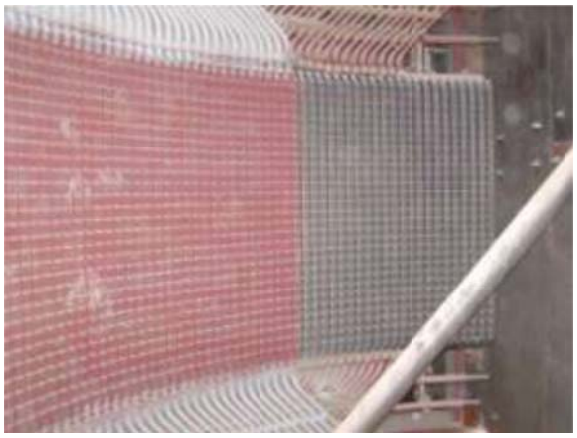
The generator stator was transported to Kajaki in two halves in open top steel armor plated containers. The havles were partially wound with those coils missing that involve the stator splits. Upon arrival at Kajaki, a roof was installed on each container to protect the sensitive winding from rain and dust.

Prior to the roof installation, the stator halves were heavily contaminated with dust and dirt during the trip over unpaved roads. The windings were further contaminated with spider webs during the long storage period. The back of the core iron nor the outside of the generator frame could be inspected due to the placement of the steel armor plating.

Rotor spider, rotor rim, stator sole plates, and bearing brackets were in good condition except the rotor rim steel plates (laminations) are dirty and rusty but usable. The rotor rim steel plates will require refurbishment prior to installation.

The workmanship of the stator winding installation appeared to be satisfactory and the winding appeared to be properly supported to be able to sustain short circuit forces. The stator slot wedges were found to be excessively loose. This could be due to a combination of installation technique, transportation movement and vibration over sea and land, and a sustained storage period.

Two views of the stator showing heavy contamination of dust, dirt and spider webs



View of stator portion from within the bore area.

Cloose-up of stator bore and slot wedges.

The 24 RTD cables were left casually bundled at the top of the stator core. None of the cables were labeled or otherwise marked as to location or function. Some difficulty will be encountered during installation in identifying the RTD locations.

Preparing stator RTD's for testing.

Standards for Testing

IEEE 43-2000 and IEEE 95-2002

Testing

The loose ends of the windings were bonded together to test all portions of the winding to ground simultaneously. The RTD's were shorted and gounded during the tests. The windings were megger tested to ensure that they were in servicable condition and had not sustained any physical damage in packaging or transit.

The first half of the stator was tested at 500 Vdc and again at 1,000 Vdc. The 500 V test of the insulation resistance indicated a winding insulation resistance of 6.23 gigΩ after 1-minute. The 1,000 V test showed a resistance of 7.03 gigΩ. When an attempt was made to test to 2,500 V, the leakage current was excessive and the test was aborted. A repeat test at 1,000 V revealed that the winding was still sound after the 2,500 V test.

The second half of the stator was tested in the same sequence as the first half, except that the voltage was applied for 10-minutes to determine a polarization indes (PI). The results were as shown in the following table.

Table 4 – 1

Test Voltage	1-min. Res.	10-min. Res.	PI	Capacitance	Temperature
500 Vdc	6.5 gigΩ	42.7 gigΩ	6.6	.0243µf	3.8°C
1,000 Vdc	7.6 gigΩ	48.6 gigΩ	7.2	.0248 µf	3.8°C
2,500 Vdc	Excess Current – Test Aborted				

The megger testing could not be performed to the voltage level desired due to the contaminated condition of the winding. Complete testing needs to be done when the generator is installed. The preliminary testing did not indicte any problems other than contamination.

The Stator winding Roebel bars for completing the winding after the two halves of the stator are married were shipped separately in a large crate. Included in the crate are 94 bars for the slot tops and 34 bars for the slot bottoms. The crate had outward evidence of having been exposed to the elements (always left outdoors) by a heavy accumulation of dust, dirt, water stains and rodent waste. The interior of the crate showed evidence of heavy free water intrusion to the extent that the plywood separators between top and bottom layers of bars were completely dry rotted and the sponge packing material was heavily stained and mildewed. The mildewed packing had adhered to the bar surface, including the slot sections. Some of the bars were sounded (tapped) and some produced a hollow sound instead of producing a sharp ring. Because the bars have been exposed to extended periods of dampness and they exhibited delamination when sounded, they will not provide a full service life of operation. Because of the condition of these bars KHPP has assumed to replace all 94 top bars and 34 bottom bars.

Conditions inside the crate housing the stator bars for the open slots. Water damage, mildew, dry rot and rodent waste.

In a separate crate, 23 top bars and 4 bottom bars are provided as spares. These are enough spares to allow a winding repair in the event on an in-service failure in the future. Unlike the bars described above, these bars are in good condition. The crate had not been damaged nor allowed to deteriorate in the weather. They will continue to provide back-up for an extended period of time going forward.

The 24 stator winding embedded RTD's were tested for continuity. One of the 24 was shorted out. It is possible that the wiring has been crushed and may be repaired during the installation of the generator. If not, the loss of one RTD will not affect the proper operation of the temperature monitoring system. It was also noted that the color coding of the RTD leads was not consistent. This will cause extra work and testing during installation, but not a major impact.

The eight generator air/water coolers (heat exchangers) were found on site. The units are painted generator green. The water connection piping flanges were rusty and will need to be cleaned up before this piping can be installed. A static water test should be performed on site before the coolers are installed.

The collector ring brush assembly insulating hardware was found to be loose and will need to be tightened during erection. The brush contact surfaces of the collector rings are protected with a black preservative for the most part. Some areas were missed and the contact surface is rusty in those areas. The rust must be removed by hand polishing at the time of erection. A 500 vdc megger check was conducted to check the integrity of the insulation: Top ring to bottom ring - 48 gigΩ, Top ring to ground - 20 gigΩ, Bottom ring to ground - 22 gigΩ. These readings are acceptable.

The generator bus leads were found to be badly bent in bowed condition due to a crushed and deformed crate. The bus sections will need to be straightened before installation and then bench tested. If the leads fail hi-pot testing, they will have to be hand re-insulated on site. This can easily be done since personnel and insulating materials will already be on site for the normal erection process.

Main generator bus leads found bent (bowed) in the shipping crate.

Painting materials were found for the winding, rotor, and rotor lead assembly. The paint is rated Class F and is red and gray in color. The material has been stored for over 3 years in an area of extreme temperatures and due to this exposure, the shelf life and the servicable life as insulating varnish has been exceeded and the material will have to be properly disposed of and replaced.

Field poles were found in crates in the Laydown Yard. The roof of one crate was severly deteriorated and the side of another crate appears to have been damaged. The pole assemblies included steel poles that were rusted and heavily contaminated with dust and dirt. The inner field pole collars (washers) were sitting loose on winding with the first turn of the winding loose. It is not known if the rust or deterioration has damaged the groundwall insulation. At the time of erection these poles will be dissasembled and thoroughly cleaned to ensure that rust or deterioration has not damaged the groundwall insulation.

Badly deteriorated crate housing generator field poles. Cover was dilapidated and allowed water intrusion which rusted the pole bodies. The insulation on these poles cannot tolerate moisture contamination.

Generator Thrust Bearing

The generator thrust bearing runner (rotating plate) was found with evidence of heavy dirt and dust intrusion into the packing of the bearing. The plywood cover of the crate was completely disintegrated by weather exposure. Condition of the runner face is unknown and was not inspected due to lack of material to repack and properly preserve. This item is crucial to the generator and connot tolerate rust pitting or marring. Consequently, even if this runner is in good condition, we recommend a spare runner (rotating plate) be purcahased as it is prudent to have a spare on hand to complement the spare set of thrust bearing shoes included with the GFE.

The thrust bearing insulation included with the thrust bearing package is made from linen bakelite material. This material is more fragile and moisture sensitive that the more resilient Nema G-10 or G-11 material used commonly nowadays. The insulation should be replaced with the better material. The remainder of the thrust bearing parts were found to be in good condition and suitable for service.

Inventory

Two generator shafts have been located. One is at the Kajaki site and the other was in storage in Kabul but has since been moved to Kajaki HPP. It is not known at this time which of the two turbine shafts on site match the generator shaft on site, but closer inspection will determine this. It can be confidently

assumed that the generator shaft on site will match one of the turbine shafts and either turbine shaft can be matched to the turbine runner.

Findings

The stator halves are badly contaminated with dust, dirt, and debris. A thorough cleaning will be necessary at the time the generator is installed and the two halves are joined together. Care is needed to be exercised to avoid damaging the winding with improper cleaning techniques or materials. After the two halves are joined, the open stator slots need to have their coils (bars) installed. Part of that process involves installing the slot wedges. At that time, all slots with factory-installed wedges should be re-wedged. The wedges were found to be excessively loose and if not corrected, the service life of the winding will be significantly shortened.

One winding RTD is inoperative and will be replaced if it is removable. It was noted that the brazing on the uninsulated stator winding clips was marginal but acceptable.

The 150 stator winding Roebel bars for completing the winding after the two halves of the stator are joined are in poor condition due to improper storage and should be replaced.

The generator air coolers are rusted, could be dificult to clean acceptably, and require pressure testing to assure operational performance. Due to potential schedule impact if coolers cannot be refurbished, it is recommended the coolers be replaced.

The generator thrust bearing sheet insulation should be replaced with an insulator made from superior material (Nema G-10 or G-11 epoxy glass laminate).

The 2-part epoxy paint kits supplied for the generator have exceeded their shelf life and need to be replaced. Shelf life for this type of material is one year and this paint has seen over 3 years of high temperatures and consequently cannot be relied upon to set up properly. It is anticipated to purchase 65 gallons of replacement 2-part epoxy paint kits.

Recommendations

1. Thoroughly clean the winding
2. Re-wedge the stator
3. Perform acceptance testing per IEEE standards
4. Replace all stator bars shipped separately for the open stator slots
5. Clean rust from collector rings
6. Tighten collector ring brush rigging insulation hardware
7. Replace thrust bearing insulation
8. Provide a spare thrust bearing runner
9. Straighten the generator winding bus bars and test
10. Replace generator coolers
11. Inspect, clean and test field poles

The recommended refurbishing activities can be performed on site. The schedule accounts for these activities.

KHPP incorporated the procurement of thefollowing generator related items into its Unit 2 Installation subcontract supply scope:

- 150 stator bars
- Thrust bearing insulation
- Air coolers
- Generator thrust bearing runner

4.3.6 Excitation System

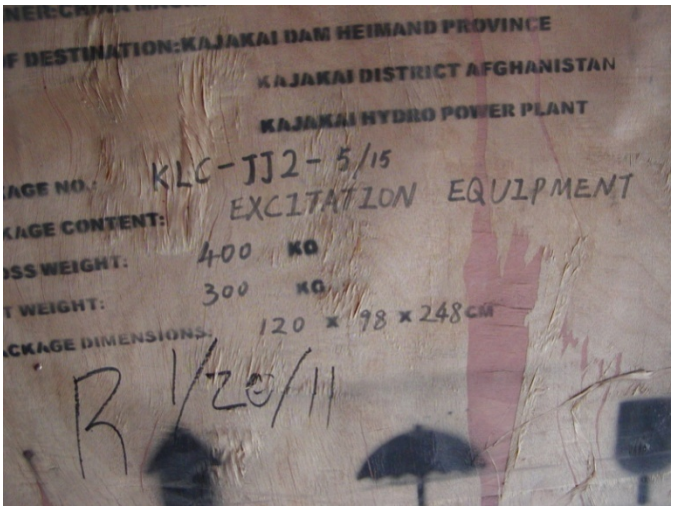
Equipment Description

The excitation system consists of a supply transformer, thyristor rectifier, automatic voltage regulator, field isolation device and a discharge resistor.

Observations

The excitation equipment was shipped in 15 separate crates. Except for some minor crate damage caused during shipping, the equipment is in good condition. None of the excitation equipment was damaged. Although the crates were double sealed, the contents were always dusty.

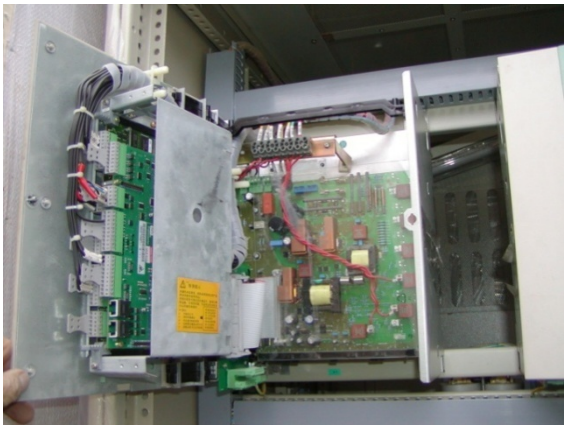
Some of the crates are very large and exceed 8 feet in height. Because there was no way to store these tall crates in the warehouse or in a container, they were not all opened. The crates are difficult to open and the plywood material is badly damaged in the process. The crate material is only ¼-inch thick low grade plywood which has been deteriorated by outdoor exposure. Representative crates were selected for uncrating and inspecting. In all cases, the contents were well protected and in good condition, only dusty.



Typical Excitation Equipment crate markings. Note weathering although an umbrella indicates indoor storage.

There was evidence of water intrusion into one crate and onto the panel door although the water did not appear to have entered the cabinet interior.

Water stains on exterior of excitation cabinet.



Interior of cabinet is in good condition. No water intrusion and no physical damage. Light dust on all interior components.

4.3.7 Generator Neutral Cubicle

Equipment Description

Apparatus used to ground the generator stator winding. Equipment includes disconnect links, grounding transformer and loading resistor.

Observations

The neutral grounding equipment cubicle is contained in a single shipping crate. The crate was opened and the contents inspected. All contents were in good condition. There was no evidence of physical damage to the grounding transformer or the resistor bank.

Generator neutral grounding transformer.

Resistor bank, disconnect links below.

4.3.8 Generator Switchgear

Equipment Description

CMIC drawings and documentation indicate the 13.8kv switchgear consists of ABB vacuum breakers packaged into a line-up built by Tianjin Design and Research Institute for Electric Drive.

Physical Assessment:

The 13.8kv switchgear cabinets staged in the GFE Inventory Laydown Yard at Kajaki Dam were not examined (uncrated or removed from packaging). In the original Draft Inventory and Condition Assessment Report, it was recommended that this switchgear be replaced for reasons presented below. Because the intent is not to use the provided switchgear because it is not of arc resistant construction and presents a hazard to personnel, the Assessment Team resources were not spent assessing this equipment. Most of the breakers and other apparatus packaged separately from the cabinetry were, however inspected. Megger checks were made on some of the breakers and the insulation resistance was satisfactory. In all cases, the apparatus was in good condition and serviceable.

The existing cabinet crating is deteriorating and has been protected by covering with polyethylene sheeting and new tarpaulins.

Engineering Assessment:

The CMIC design includes a 13.8kv switchgear breaker line-up to support addition of Unit 2 but does not include sufficient 13.8kv feeder breakers to support current distribution loads (two circuits) fed from the Power Station.

There are no switchgear provisions for spare (future) circuit breakers or in-place spare breakers that could be put into service quickly should one of the generator breakers fail or the single feeder circuit breaker require replacement.

The 13.8kv switchgear delivered to site as GFE inventory is not built to Arc-Resistant construction standards although the location of the 13.8kv switchgear is housed in the operator control room. This location (in direct / routine operator contact) poses a significant exposure and safety risk to operating personnel should an arc flash occur due to a short circuit in the switchgear.

Arc flashes in non-Arc-Resistant switchgear can cause serious injury or death to personnel in vicinity of the switchgear.

Recommendations:

1 The CMIC furnished switchgear should not be utilized in the Kajaki Power Station due to lack of Arc-Resistant construction. It was not designed nor intended for any 13.8 kV loads, only for connection to the 13.8/110 kV transformer. The switchgear lacks in-place spare cubicles or circuit breakers to replace failed breaker equipment. It lacks support to feed 380v/220v station service loads from the 13.8kv generator buss where station services are available from any operating Unit and future 13.8kv powerhouse load expansion.

2 Acquisition of a replacement 13.8kv switchgear line-up constructed to Arc-Resistant standards that include the additional circuit breakers necessary for the application requirements to support a revised station service configuration and in-place spares should be included.

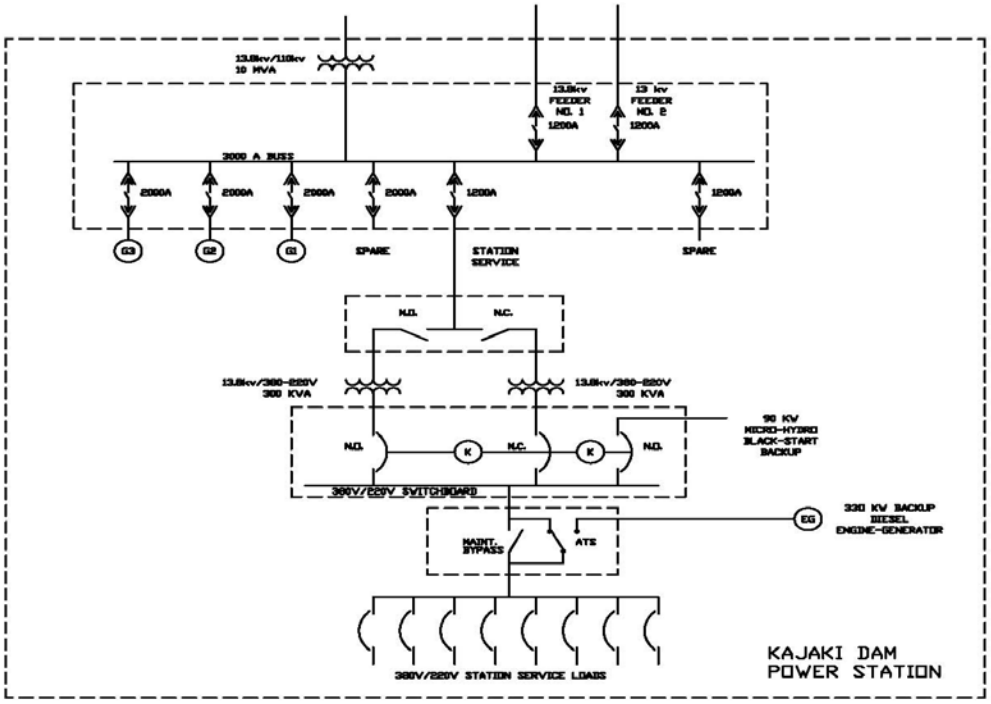
The 13.8 kV switchgear furnished as GFE for Unit 2 could be used elsewhere in the regional electrical system in an appropriate application.

USAID accepted t he recommendation to replace the existing GFE switchgear with new Arc-Resistant switchgear including additional circuit breakers to isolate the station service system and 13.8 kV distribution system from the generator bus. KHPP's Unit 2 electrical design modified the original CMIC design to reflect this approach. Completion of this design has been deferred until the new switchgear is procured as equipment shop drawings are required to complete the design. The procurement of the new switchgear and completion of the related electrical design was incorporated into KHPP's Kajaki Unit 2 Installation subcontract package.

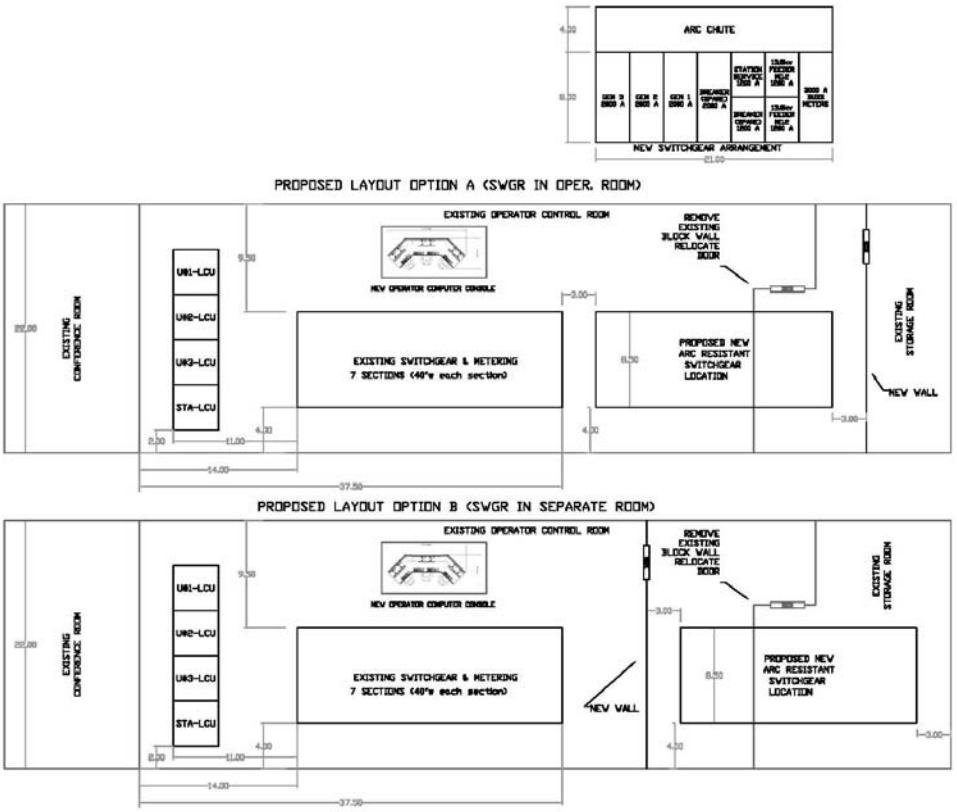
The insertion of a new circuit breaker in the new switchgear to isolate the plant bus from the 13.8 kV local distribution system largely protects the plant from the current ground fault issues. However,

design of the new Kajaki 13.8 kV switchyard by others must be coordinated with this Kajaki plant design to optimize plant protection.

PROPOSED POWER STATION / STATION SERVICES SINGLE-LINE



PROPOSED SWITCHGEAR LOCATION



4.3.9 13.8 kV Non-Segregated Phase Bus Duct

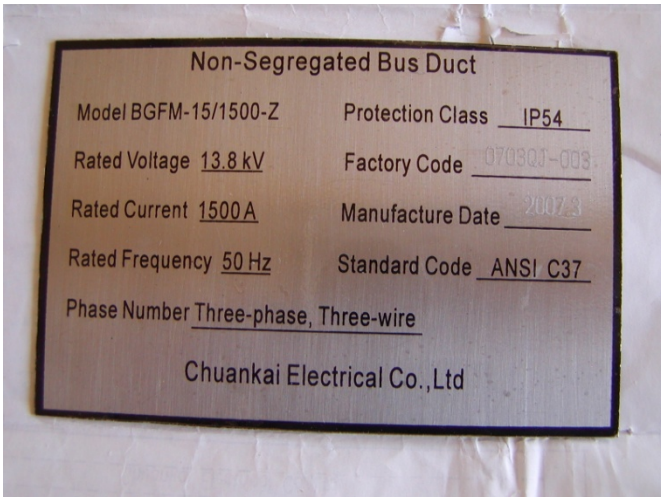
Equipment Description

Non-segregated bus duct to connect the main generator with its excitation transformer and circuit breaker.

Observations

The bus duct sections were packaged separately in 9 crates. Included with the bus duct sections are hardware and stand-off insulators. There are straight, elbow and expansion sections in the array. Also included in separate crating are the bus segments with connecting hardware. All duct sections and the bus bar are in good condition.

Section of bus duct.



Non-Segregated Bus Duct Nameplate

Various sections of ladder-type cable tray are also provided. The cable trays are constructed of galvanized steel. All were found to be in good condition.

Galvanized ladder-type cable tray.

4.3.10 Main Transformers

Equipment Description

4 ea. – Two-winding step-up transformer, outdoor type, single-phase, 15/20/25 MVA, ONAN/ONAF1/ONAF2, 13.8/63.5kV, oil immersed.

Note. The transformers are single-phase and when connected in Y configuration, the phases voltage becomes 110kV (63.5 x 1.732 = 110kV)

The condition and utilization of the 13.8/20kV transformers (GFE) is addressed in the *Kajaki Hydro Plant Transmission and Distribution Facility Report-Draft*.

Observations

Four transformers are now stored at the Kajaki Laydown Yard. Three of the transformers are the single-phase units designated for the powerhouse generator step-up (GSU) main bank. There is a fourth transformer which was originally at a storage warehouse in Kabul but was subsequently moved to the KHPP Laydown Yard in Kandahar and then moved to the Kajaki HPP. This transformer has been identified as a spare for the three primary transformers.

The transformers at Kajaki are still mounted in their shipping containers that are equipped with armor plating, presumably for protection from small arms fire damage in transit. The transformers are stripped of their large auxiliaries and bushings. The A-Phase transformer had its access ladder cut loose and was found in the bottom of the container. Apparently the ladder interfered with the armor plating and had to be temporarily removed. There did not appear to be other than superficial damage to any of the units.

Testing

It would have been desirable to test the transformer winding insulation resistance, but it was not possible because the bushings are not installed.

The atmosphere in the tank above the oil should have been sampled for its dew point, but there was no gas piping on the transformer and all transformers were found to be under a slight vacuum. Gas could not have been drawn out under these circumstances and it was considered undesirable at this time to admit outside air into the transformers. They are all three tight and leak free and should not be exposed to outside air since they will be in storage for an additional undetermined time.

An oil sample was taken from each of the three transformers at Kajaki for laboratory analysis to determine its suitability for use. Since these transformers have been stored for an extended period of time without supply of dry gas, an oil test will determine if there has been an intrusion of moisture into the tanks. A sample of oil was not taken from the fourth transformer in Kabul. The original laboratory selected for the oil testing could not perform the required testing. Additional samples were taken

during the second assessment and were tested by a different laboratory. The final test results are presented in Appendix 14 and are summarized below:

- Water Content – All three GSU transformers had water in the oil in excess of the limits for "Test Limits for New Insulating Oil Received in New Equipment". The limit for transformers of 110 kV is 10 ppm and the transformers tested 14, 13 & 15 ppm.
- The Tangi Sub transformer water content was acceptable since its limit is 20 ppm due to its lower voltage class.
- The bulk oil sample tested 15 ppm which is acceptable because the acceptable limit for new oil as received from the supplier is 25 ppm (It is OK to purchase oil at 25 ppm water, but it must be processed to 10 ppm or less for use in a high voltage transformer).
- Based on the water content, the oil in the transformers and in the drums was not vacuum processed adequately or sufficiently before the apparatus was shipped.
- Acid Number – All but of of the five samples exceeded the limit for acid number. Since the transformers have not been in service, the elevated acid numbers are probably due to residual from the refining process.
- Color – Color for new oil as supplied should be 0.5 and for new oil in a transformer should be no more than 1.0. All but one of the samples exceeded the recommended limits. Oil darkens with heat in use and age but since this oil has not been in service, the color originates from the refining process.
- Dielectric Breakdown – The oil in the B-Phase transformer did not meet the minimum breakdown voltage per ASTM D1816 of 30 kV. It tested at 27.46 kV. The ASTM D1816 test is more responsive to particulates and dissolved water than ASTM D 877. The lower test value may be indicative of electrically conductive contaminants.

Since there is no oil level gage on these transformers, the oil level was determined by installing a temporary external sight glass of plastic tubing from a bottom radiator to the top fill valve. This was accomplished without admitting any outside air into the transformer tanks. The oil levels were found to be sufficiently high to ensure that the internal core and coils are entirely submerged in oil, a requirement for transformers in extended storage. The oil levels at 13°C were found to be as follows:

Table 4 – 2

Designation	Serial Number	Ambient Temperature	Oil Level
A Phase	GA 4301	13°C	3.5 inches from bottom of cover
B Phase	GA 4302	13°C	14.5 inches from bottom of cover
C Phase	GA 4304	13°C	4 inches from bottom of cover
Spare	GA 4303	N/A	Not checked

Inventory

Although not common practice for large transformer shipment, the control boxes (panels) had been removed from each transformer. It is presumed that the panels were removed to prevent damage in shipping and/or to provide more room for installing the steel armor. All four control boxes were located during the inventory. The boxes are constructed of stainless steel and were found to be in good condition. There was no damage to the boxes or to the control devices inside. The forced-air fan controllers are included inside the boxes.

The radiators, fans, conservators, bushings, HV CT's and lightning arresters (LA's) were all located and examined. The HV CT's are housed in a steel bonnet type assembly meant to be mounted under the HV bushings. Inside the bonnet are three separate CT's, all with 500:5 ratios. One CT is of accuracy class 0.2, the second 3.0 and the third 5P20.

The only damage to any of these components was some minor paint damage to the radiators due to rubbing during shipment, slight paint rub on all conservator vent pipe flanges, and one CT's vent pipe slightly bent.

HV CT Assembly

Slight paint damage to conservator tank vent line flange.

Each transformer requires 4 radiators and four cooling fans. All have been accounted for. All of the accessories for the fourth spare transformer are stored with the GFE at Kajaki Dam.

The transformer drawings indicate that the transformers are to be equipped with wheels and installed on rails. The wheels were found inside the crates with the conservator tanks and the rails were shipped separately. It is unclear if the transformer installation has accounted for the wheel and rail increased overall height of the transformer. This is critical because the LV bushing compartment has to match the existing non-segregated bus duct arrangement. The possibility of installing these transformers without the wheels and rails should be investigated so that the bus duct alignment can be accommodated.

There were no GSU transformer spare parts included in the GFE.

Findings and Recommendations

There will need to be oil added to each unit, as the radiators and conservator tanks are installed. There is replacement oil on the site as part of the GFE for this purpose. The oil is stored in sealed 44 gallon drums. 74 drums are on site, but 13 of them are designated for the transformer to be installed at Tangi Substation.

A portable oil processing unit will be required for adding oil to the transformers as the radiators, bushings and conservator tanks are installed (New oil is not of high enough quality to be added directly to a high voltage transformer). A small insulating oil processing unit was located with the GFE material in the powerhouse, probably in keeping with the "Supply and Refurbishment of Turbine/Generators" requirement of the specification. This processor is probably sufficient for processing make-up oil for the transformers, but if the oil has to be lowered below the winding insulation to accommodate bottom connection of the LV bushings or for any other reason, a full-sized trailer-mounted vacuum processing unit will be required.

As a minimum, the oil in the GSU's should be vacuum processed with heat before placing the units in service. The processing should be done after the transformers have been assembled with the radiators, conservators and bushings installed. Addition of these accessories will require make-up oil from the drums already on site. The make-up oil will be processed simultaneously with the oil already in the transformers. As a precaution, each drum of oil should be tested with a portable dielectric breakdown tester (per ASTM D877) before the oil is used to ensure that water or electrically conductive contaminants are not introduced into the transformers.

Proper vacuum processing will remove the excess water from the oil and remove most of the water from the transformer paper insulation. It should also improve the dielectric breakdown voltage of the B-phase transformer. The on-site processing will not, however, improve the acid number or the color of the oil.

There is a very small transformer oil vacuum processing unit on site, but it appears to be intended for processing make-up oil only and not for large volumes as is found in the transformers. A more substantial vacuum processor would be advisable. Processors of this type are normally semi-trailer mounted.

The transformers were found to be in outwardly good condition.

4.3.11 Control, Metering, and Protection Boards

Per the CMIC drawings and GFE Inventory List, the Control, Metering, and Protection Boards in GFE Inventory consist of the following control panels:

- UNIT1-LCU
- UNIT2-LCU
- UNIT3-LCU
- STA-LCU

Physical Assessment:

The Control, Metering and Protection systems were provided in ten separate crates. The crates are very large and are in excess of 8-feet in height. Due to their height, they cannot be stored in the Conex type containers and they could not be moved into the interim "warehouse" in the laydown area. Four of the crates were selected for uncrating and inspection. None of the crates had sustained any significant shipment damage and the contents of the inspected crates were found to be in sound condition. Due to the consistent good condition of the material in the crates examined, it was decided not to open them all due to the problem of adequate storage and concern for exposure prior to use.

One of the Control Equipment crates (KBB TJ2 9/10) contained computer equipment, office equipment, and supplies. It also contained panel meters, transducers, computer cabling, wiring, Dell desktop computer (not visible), printer, 2 ea. monitors, scanner, steel racking, filing cabinets, etc. One MW meter has a broken face. Other equipment is in good condition and has not been damaged by moisture or shipping abuse. The crate was moved from the Laydown Yard to Container #3 due to the fragile nature of the contents, risk of loss and possibility of rain damage. This material may also include software for the turbine/generator control scheme, but it was not verified.

Engineering Assessment:

Based on documentation available to the assessment team, there is every indication that the LCU (Unit 1, 2, 3, and Station) panels were assembled, wired, and shipped to Kajaki Dam site ***without final approval of all design drawings***. Furthermore, ***there is no indication that the Supervisory Computer And Data Acquisition (SCADA) system computers were included in the shipment of equipment to Kajaki Dam***.

Documentation available to the assessment team indicates the SCADA system configuration and PLC application programs were not completed (or perhaps never developed).

The lack of any listing of SCADA equipment in GFE inventory, no documented evidence of SCADA software configuration, PLC application programming, and ***no evidence of an integrated factory test of the system prior to shipment will result in significant problems and delays (and costs) in the installation and start-up of Unit 2, as well as Unit 1 and 3 upgrades due to the PLC and SCADA re-programming inevitable with such an omission***.

Finally, the CMIC design drawings indicate that Unit 1 and 3 LCU panels are built identically to Unit 2. However, there is no documentation to verify that the field components in existing Units 1 and 3, which are monitored and controlled by the new Unit LCU panels, do "in fact" match the field components (final elements) supplied as part of Unit 2 installation.

A detailed field assessment of the existing Unit 1 and 3 field control and monitoring devices must occur to verify consistencies with pending Unit 2 field devices.

It is unlikely that Unit 1 and 3 field devices match Unit 2 field devices. In the event Unit 1 and 3 field devices do not match the field devices for Unit 2, there are two paths forward to accomplish the upgrades of Unit 1 and 3 control systems.

Option A – Modify / replace any Unit 1 and 3 field devices that do not conform to the Unit 2 field devices.

Advantages: The final controls system configuration would be consistent across all operating Units.

Training of personnel to maintain the new controls would be uniform across all Units.

Any replacement field devices would have a life expectancy equivalent to new Unit 2 hardware.

Disadvantages: Option A may involve costs that are not currently anticipated in the present design.

Option B – Modify the design of Unit 1-LCU and Unit 2-LCU controls to match existing field devices.

Advantages: The costs of modifying/replacing Unit 1 and 3 field devices would be deferred.

Disadvantages: Costs would be incurred to modify Unit 1-LCU and Unit 3-LCU control panels to accommodate existing field devices that are different from Unit 2 field devices.

Recommendations:

1. The SCADA / PLC control system must be configured and a comprehensive factory test performed in a controlled environment (off-site) to ensure the integrated PLC application software and SCADA supervisory software is in compliance with specifications and performance requirements. This will minimize disruptions and the time involved during the controls conversion and start-up of each operating Unit. Once the SCADA software is developed off-site, final testing of controls for all three units could be performed on site.

2. An analysis of Unit 1 and Unit 3 field devices should be undertaken with the goal of modifying / replacing field devices that are inconsistent with the controls architecture of Unit 2 – implementation of Option A.

USAID accepted t he above recommendations. The procurement and associated programming of new control PLC's was incorporated into KHPP's Kajaki Unit 2 Installation subcontract package.

4.3.12 Station Auxiliaries

Per the CMIC drawings and GFE Inventory list, the Station Auxiliaries consist of the following items:

- A CMIC drawing indicating proposed routing of Unit 2 buss-duct to the 13.8 kw switchgear.
- 300 KW diesel engine-generator for backup of 380v/220v station services loads.

Per previous CMIC scope of work documents, the following items were to be furnished and installed:

- Cable trays and supports
- Lighting and emergency lighting systems
- Distribution panelboards
- Conduit, boxes and fittings
- Wiring and misc. devices
- High-voltage cable
- Power cable and wire
- Control and communications cabling
- Grounding
- Miscellaneous devices

Physical Assessment:

Diesel Generator

A diesel engine driven generator was delivered as part of the equipment. It is described as a Cooltech Power Genset rated 300 KW (depicted in outline Dwg. KAJK-TE-8.25-01-A). The genset was not uncrated, but the crate was not damaged in shipment and therefore the generator is considered to be in serviceable condition. The genset accessories are packaged separately in Pkg. No. KJ U3-01/02. The accessories were inspected and all found to be in good condition. The accessories include: 1 ea. muffler, 2 ea. 27 mm exhaust elbows, 1 ea. 127 mm exhaust flex connector, 6 ea. 127 mm U-clamps, 1 ea. toolbox with misc. hand tools, 1 ea. 12 V. 200 ah battery, battery support shelf, 12 sets of Instruction Manuals, 12 CD's of the instruction manuals, 2 ea. large keys.

Lighting System

A lighting system was provided with the crate contents described as 400 V LV in Pkg. No. KDY TJ2-01/01. The equipment consists of powerhouse lighting accessories including 36 piece MCCB , 6 sets of emergency lights and 2 sets of accessories. All items were found to be in good condition and usable.

Cable Accessories

There were 65 sets of cable termination kits found, both indoor and outdoor types, in addition to a set of galvanized cable trays and hardware, cable stress cones, and 3 types of self-vulcanizing tape. It is assumed that this material has a shelf life of less than 3 years and since that timeframe has been exceeded, the material should be replaced. Chinese manufacturer's recommendations for shelf life and storage instructions were not available.

Cable

There were 13 reels of cable inventoried of various conductor sizes and lengths. Data was added to the GFE spreadsheet to indicate the size, voltage class and length of the supplied cables. Some of the reels were damaged, the cables were dirty and dusty and it has been assumed they may be adequate. Testing cable required use of high voltage test apparatus, which the assessment team could not bring to site. Further, testing unshielded or cable on a reel is not recommended. Testing can be done once the cable is installed. However, due to potential schedule delay during construction, if the cable is determined to be damaged and require replacement and inability to get replacement cables in a timely manner KHPP has assumed replacement of these cables. Data was added to the GFE spreadsheet to identify those reels with damage. There were two "rolls" of cable identified on the GFE only as DL TJ3 that were not located.

Line-up of cable reels of various sizes and voltages.

KHPP has procured and delivered to Kajaki HPP replacement cable.

Self-Cleaning Cooling Water Strainers

There are two electric motor-driven and differential pressure controlled automatic strainers. These units were reportedly damaged when they fell from a truck while being unloaded by hand. The strainer drive motors were crushed, the differential sensor was broken and the automatic dirty water drain controller was broken. These items will need to be replaced due to their unusable condition.

Self-cleaning strainer with damaged drive motor and differential pressure controller.

KHPP has procured and delivered to Kajaki replacement cooling water strainers.

Batteries

There was a crate of 10 ea. 12 V 145 AH batteries in the inventory. It was obvious that the shipping crate originally contained 20 batteries, **but half of them were missing** and had been removed previously by person/s unknown (A station battery system of 220 Vdc as specified would require 20 ea. 12 V batteries). Since half of the batteries are missing and the remaining ones have been sitting idle for three years without being charged, they will be replaced with new batteries.

Engineering Assessment:

Only two (2) drawings are included in documentation provided to assessment team. One drawing indicates a proposed routing of the Unit 2 buss duct to the 13.8kv switchgear. The other drawing is a physical outline of the diesel engine-generator.

There are no drawings indicating cable tray routing other than the single Unit 2 buss duct proposed routing. There are no drawings indicating lighting system(s) layouts. There are no drawings indicating which distribution panel boards are replaced and which existing panel boards are being expanded using additional circuit breakers. There are no details on sizes and capacities of proposed electrical cables or conductors (including voltage rating or types of installation). There are no details on proposed grounding or any communication cabling and networks.

4.3.13 Station Service Modifications

There are two (2) CMIC drawings related to station service modifications:

- (KAJK-TE-10-01-C) 13kV interlocked dual-source isolation switch for the two existing 300kVA13.8kV/380-220V station service transformers.
- (KAJK-TE-10-2-A) CMIC brochure indicating the proposed model of low-voltage circuit breakers proposed to be replaced in the existing station services switchgear.

Per previous CMIC scope of work, documents requires an on-site assessment and refurbishment of the existing station services transformers.

Physical Assessment:

The 13.8kV dual source isolation switch was uncrated and examined. It was found to be in good condition and suitable for service.

The GFE Inventory List did not make specific reference to proposed replacement station service switchgear circuit breakers and it is unknown if such units were provided.

Engineering Assessment:

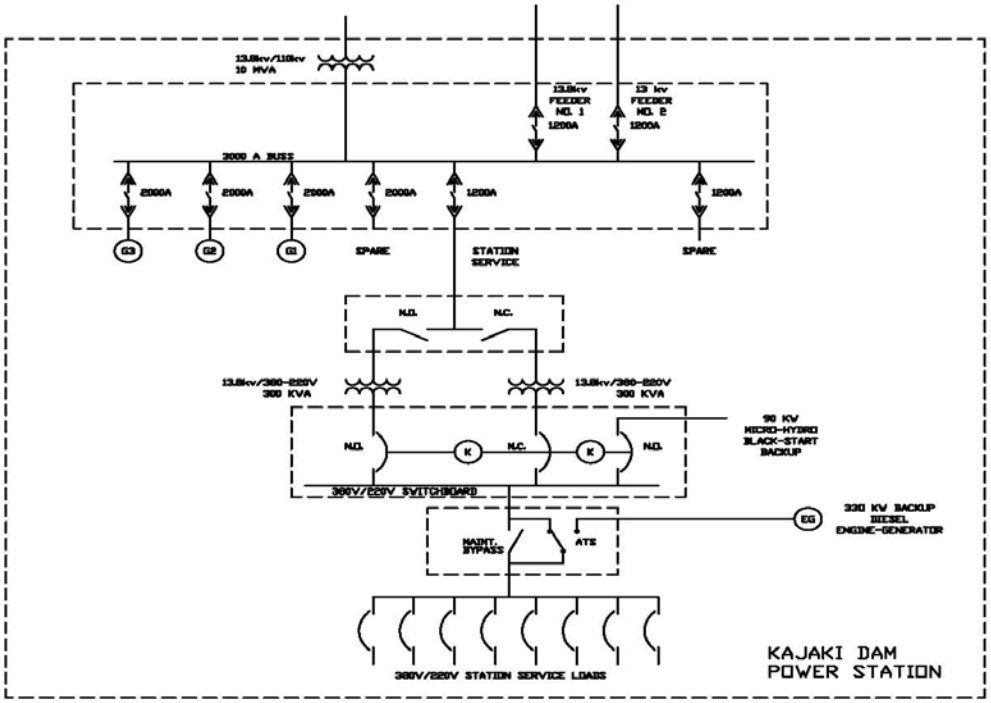
The existing power distribution to the 380V/220V station service loads are fed through two (2) 300 kVA 13.8kV/380V-200V transformers that are directly connected to the generator output terminals. This is a non-standard configuration that does not support Unit 2 only operations. In essence, station service requires either Unit 1 or Unit 3 to be on-line and operating in order to have station service power. ***This is not an acceptable design for flexible operation of the facility.***

Recommendations:

The configuration of the station service distribution should be re-configured to be fed from a feeder breaker in the 13.8kV switchgear. This feeder would be connected to interlocked 1VA 13.8kV/380-220V station service transformers. The secondary of the station services transformers would be connected to an interlocked 380V/200V switchboard to support connection to the 'black start' micro-hydro generator (existing but in need of repair), and an Automatic Transfer Switch (ATS). The ATS must include an ATS maintenance bypass. The ATS would be connected to the new diesel-fueled engine-generator and to station service loads.

KHPP's Unit 2 electrical design has reconfigured the station service distribution system per the recommendation and incorporated it into the Kajaki Unit 2 Installation subcontract package

PROPOSED POWER STATION / STATION SERVICES SINGLE-LINE



4.3.14 Loose Materials

Observations

In general, mounting and assembly hardware and sometimes wiring was found in the shipping crates with the components to be installed. In most of these instances, the hardware was simply "dumped" into the crates without first being packaged or bagged. This practice has made it difficult to ascertain if enough of the hardware was included.

Examples of how hardware and accessories were shipped.

Loose materials consist of piping, nuts and bolts, cans, drums, etc. with insufficient labeling or other forms of identification to indicate its function or use. Some of these materials are stored in the "at large" areas and others are in containers. Still others were in wooden crates with no detailed packing list attached.

There are 13 reels of electrical cabling in the GFE inventory. The origin tag indicates the type and length of cable on the reels, but no designation as to its intended use. The inventory list shows two additional "rolls" of cable both with the designation DL TJ3, but they have not been accounted for. Some examples are shown below. Some of the cable reels were damaged in shipment but the cable appears to be in serviceable condition.

中国机械对外经济技术合作总公司
China Machine-Building International Corporation
Machinery Mansion 248 Guang An Men Wai Street, Xuan Wu District, Beijing, China 100055
运输唛头
Shipping Marks
详细装箱单
Detailed Packing List
KAJAKAI, AFGHANISTAN
TIANJIN, CHINA
收货人 Consignee EMPRESA DE DISTRIBUICAO DE ELECTRICIDADE-EDEL-EP
日期 Date 18-Apr-07
箱件号 Package No. DL-TJ3-4/13
Page No.
工厂编号 Work Order No. 26482195-3
设备名称及规格 Description 电缆及备件 Cables & Spare Parts
部件名称及规格 Subassemble

商品代码 Item No.	图号 Drawing No.	品名及规格 Description & Specification	单位 Unit	数量 Quantity
85446012		YJV-8.7/15-1*240	M	800

Cable reel is damaged but condition of cable is uncertain.

Detailed Packing List: 800 M of YJV-8.7/15-1*240

Table 4 – 3

43	TJ CK1-01/10	Unit #2 CAE	Cable	Cable Tray	Container # 01; Package Not Readable	1	Wooden Case
44	DL TJ3-04/13	Unit #2 CAE	Cable	Cables	Container # 02	1	Wooden Case
45	DL TJ3-11/13	Unit #2 CAE	Cable	Cables	Container # 02	1	Wooden Case
46	DL TJ3-02/13	Unit #2 CAE	Cable	Cables	Laydown Yard; Lower Camp	1	Wooden Case
47	DL TJ3-03/13	Unit #2 CAE	Cable	Cables	Laydown Yard; Lower Camp	1	Wooden Case
48	DL TJ3-06/13	Unit #2 CAE	Cable	Cables	Laydown Yard; Lower Camp	1	Wooden Case
49	DL TJ3-08/13	Unit #2 CAE	Cable	Cables	Laydown Yard; Lower Camp	1	Wooden Case
50	DL TJ3-13/13	Unit #2 CAE	Cable	Cables	Laydown Yard; Lower Camp	1	Wooden Case
51	DL TJ3	Unit #2 CAE	Cable	Cables	Container # 02; Package Not Readable	1	Roll
52	DL TJ3	Unit #2 CAE	Cable	Cables	Container # 02; Package Not Readable	1	Roll

Representation of GFE Inventory List showing the cable reel as Item 44. Designation is "Cables" with no details.

The designation: YJV-8.7/15-1*240 under “Description and Specification” does not indicate what type cable it is or where it is to be installed without further information being provided. Logical assumption that the cable voltage rating is 8.7/15 kV and the cable is single conductor (1/c) of size 240 mm^2.

KHPP has procured and delivered to Kajaki HPP replacement cable.

Large reel of cable: 400 m, 450/750 v., 4/c 4@ 1.5 mm^2

Piping of varying sizes, types and amounts were stored “at large” in the lay down area. The piping is rusty, but otherwise in satisfactory condition. There is no identification on the piping and the GFE Inventory List is vague as to description and amount. The piping is for the air, cooling water or lube oil systems.

Loose piping in Laydown Area. Material is rusty but undamaged. No labeling or marking present.

Table 4 – 4

378	N/A	Unit #2 CAE	Piping	Various Large Gauge Pipe	Laydown Yard; Lower Camp	1	OPEN CARGO

Excerpt from GFE Inventory List showing quantity of pipe as "Various".

Another piping inventory bundled in a steel crate. Some of this pipe is SS.

KHPP incorporated replacement of miscellaneous piping in the Unit 2 Installation subcontract package scope.

A quantity of nuts and bolts and other hardware were found stored loose with no crate or markings of any kind. The bolts are of steel and are heavily rusted. It could not be determined from visual examination whether they are corroded beyond use or just have superficial rust. Their suitability for use will depend on the extent of the corrosion and their intended use.

Nuts and bolts and a sole plate stored openly without crating or any documentation.

The bolting for the Inlet Valve and spool segments was not found nor was it identified on the GFE. 144 bolts are required for the three flange joints and will have to be provided by the installer. In addition, the head cover bolts were likewise not found. These bolts are critical to the reliability and safe operation of the turbine and should be of sufficient tensile strength for the service intended. These bolts have been purchased by KHPP and delivered to Kajaki HPP.

A quantity of rubber type O-ring and flat gasket material was located in a wooden crate with no top, exposing the material to the elements. This material has become weather-beaten as evidenced by cracking and lack of flexibility. It is obviously not suitable for use and must be replaced.

Rubber O-Ring, shaft seal packing and gasket material exposed to weather and unusable.

Findings and Recommendations

Some of the loose materials have been exposed to the elements and as a result have deteriorated to the point of being unusable and need to be replaced. These materials include rubber O-rings, shaft packing and rubber gasket material found stored outside and unprotected. Steel bolting and other steel parts were also stored subject to weather exposure. These steel parts may or may not be useable depending upon the extent of the rusting and their intended use. Although not yet examined, other similar type materials stored out of the elements in containers may well be suitable for use.

The head cover bolting and the Inlet Valve flange bolting were not located in the material. These items will have to be provided by the installer.

The electrical cable reels have been damaged and the condition of some of the cable is undetermined. The cable on the damaged reels should be replaced as a precaution against lost time during installation. Since the Detailed Packing Lists are not available, sizes and quantities cannot yet be verified until takeoff's are developed from the construction drawings.

Subsequently, KHPP procured and delivered to Kajaki HPP the turbine head cover bolts. KHPP also procured and delivered to Kajaki HPP replacement reels of replacement cable.

4.3.15 Cross Reference by Container

The contents of all individual containers were inventoried and reconciled against the GFE. In many instances the crate markings were obliterated, however after opening the crates the contents were recognized and the particular inventory item could be determined.

As each item was inventoried, it was re-crated and stored either in a container or in the Laydown Area, depending on whether or not the item(s) could tolerate the elements. For example, the transformer radiators, fans and conservator tanks were left outside since they are intended for outside service anyway.

The contents of each container were recorded as part of the Final assessment and are included in this report for future reference and for ease in locating the material when needed.

The two containers housing a total of 74 barrels of transformer insulating oil were not disturbed, but the contents were noted and recorded.

At-large material for the most part could be identified by crate number. The identification on some crates, however, was either missing or was faded beyond recognition by exposure to the elements. As the crates were opened, however, the contents were recognized and reconciled with the inventory list.

Large uncrated pieces relating to the turbine had not been marked as to their identity or function. Most could be identified simply by experienced recognition and reconciled with the GFE Inventory List.

The original GFE Inventory List identified 386 items in the lot for Unit 2 installation. Of these 386 items, 29 items could not be located. In addition, 53 items were encountered which are not part of the original 386. Because some of the 29 not located items are inadequately defined on the original GFE Inventory List, it is possible that some of them are part of the 53 additional items encountered. A list of the missing or duplicate items is included in the original Appendix 12 in this report.

As a result of the subsequent joint inventory conducted between September and December 2013, an updated list has been created by combining original Appendices 11 and 12 into one document Amended Appendix 11 and 12. Amended Appendix 11 and 12 has assigned “Item Numbers” to previously unaccounted for or missing items. It also assigned Item Numbers to the BVSPC equipment procured under Clin 6.2 and now considered GFE. The complete Amended Appendix 11 and 12 lists a total of 443 items, including 8 items procured under C/S 6.2. This list also includes six items not located and noted missing and 16 items noted as duplicate entry.

4.3.16 Condition of Civil Works/Plant Structure

Powerhouse

Observations

The Kajaki Powerhouse consists of a concrete frame with masonry infill walls. It has concrete columns with concrete beams spanning the width of the building at the ceiling level. The roof is also made of concrete and appears to be 5 inches thick. There is a bridge crane running the entire length of the building. The crane rails rest upon a concrete beam spanning between the columns.

Concrete columns supporting the bridge crane as well as the ceiling beams. Also note the masonry in filled walls.

Concrete beams spanning the ceiling.

The masonry walls appear to simply infill the concrete frame and do not appear to provide any structural support. On the outside the masonry walls have been plastered to provide a uniform finish on the exterior of the building.

Plastered exterior finish of power house.

The upper power lines are held in place with angle iron that has been fastened around one of the building's concrete columns.

On the interior of the power house it was noticed that the masonry walls have several cracks in the mortar joints. This should not be problematic as the masonry walls do not appear to be structural.

Cracks in the mortar joints of the masonry walls are not structurally significant.

The power house consists of four levels. Level 1- Entry Deck (EL. 974.00) has a small service bay on the west end of the building equipped with a roll-up access door and is used for material storage and to load and unload materials. Level 2-Generator Floor (EL. 769.55) houses the control room and the generators. Level 3-Turbine Floor (EL.964.75) houses the turbine and the runner assembly. Level 4- contains the penstocks, penstock butterfly valve (turbine inlet valve) and turbine bypass valve. It appears that the Level 1 bay is a separate structure from the rest of the power house. Note in the picture of Level 2 that the east wall columns are of slender steel construction and not concrete as seen in the west wall of the photo of Level 1.

Level 1

Level 2

Level 3

Level 4

On level 4 (lowest level) it appears that the existing concrete has been abraded with a light chisel of sorts to roughen the concrete for future bonding of the concrete for the installation of Unit 2. Not all of the existing concrete surfaces adjacent to Unit 2 have been abraded or roughened. Also visible is a water stop that is embedded in the concrete.

The concrete has been roughened in preparation for placing of concrete for unit # 2.

Not all of the concrete has been roughened.

Water stops have been embedded in existing concrete.

A large poured in place concrete block is used to support the inlet butterfly valve on the lowest level in the power house. A smaller poured in place block is used to support the hydraulic servo that controls the valve. The servo sole plate has not been grouted. It also appears that some of the bolts to the servo were broken and a coupler was used to fasten them back together.

Large poured in place concrete block.

The servo was not grouted after installation. Note the couplers placed on the anchor rods.

Findings and Recommendations

Overall the powerhouse structure is in serviceable condition. No major repairs or modifications are needed before the installation of Unit 2 is undertaken; however, there are some minor deficiencies that were noted that could impair future plant operation.

- The exterior of the building should be re-plastered to provide increased protection to the building exterior as it has begun to weather and erode. Due to the building's plastered exterior surface, the infill mortar joints could not be completely inspected, but some cracking was noted on the exterior penetrating through the finish. Since some cracking was also noted on the interior side of the

mortar joints, it is recommended that the cracked joints throughout the structure be tuck pointed with a compatible mortar.

- A study should be conducted to investigate the anchoring method of the overhead distribution lines attached on the south side of the building. The building does not appear to be designed for this type of anchoring system. It was anticipated that the arrangement of the new transmission lines from the GSU's to the new substation will be configured such that the new lines will not increase the existing line loads on the structure. Subsequent to the site assessment, design of the new Kajaki substation was descoped from KHPP. The interface between KHPP's scope to replace the GSU transformers and the third party's scope to provide the new substation is the high side bushings of the GSU transformers. Therefore, the third party's scope should include the structural study to confirm the location and design of the anchors to the powerhouse structure for the 110 kV transmission lines.
- The cracking in concrete column as well as the minor concrete cracking throughout the structure should be sealed with a hydra-phobic concrete sealant to prevent further deterioration.
- No major leaks were noted from the roof of the structure. However, upon inspection it was noted that the roof was somewhat deteriorated. Although no major leaks were indicated at this time, it is recommended that the roof be sealed and resurfaced.
- The existing smooth concrete surfaces that will be in contact with the future Unit 2 concrete should be roughened. Before placement of the Unit 2 concrete, the existing concrete should be cleaned of dust and debris and coated with a suitable material.
- It is recommended that the standing water in this area of Unit 2 be removed and the area be kept dry for a period of time before any new concrete is placed. Also visible rebar in some areas where the concrete has been roughened should be cleaned of all corrosion and recoated to prevent further corrosion.
- All broken and modified or extended bolts throughout structure should be inspected on an individual basis and corrected as needed.
- The configuration of the new plant substation is too large to fit on the roof of the powerhouse. Therefore, no further analysis is needed to determine if the powerhouse rooftop structure can support the installation of switchgear equipment.

Repair of the exterior powerhouse masonry including tuck pointing and painting and replacement of the powerhouse roof are specifically included in scope of the KHPP Kajaki Unit 2 Installation subcontract package. Other recommendations above are included in the Unit 2 Installation subcontract package as part of the general construction requirements.

Power House Crane

Observations

The bridge crane in the power house appears to be in good working order. It was witnessed being operated under no load on January 18, 2011. Both hoists were operated as well as the bridge. Upon

inspection it was determined that the main hoist has a nameplate capacity of 115 M. Tons and is rated to move at a rate of 4.4 fpm. The auxiliary hoist has a nameplate capacity of 2000 kg.

The crane manufacture is P & H. The maker of the electronic components and controls for the crane is Cutler Hammer.

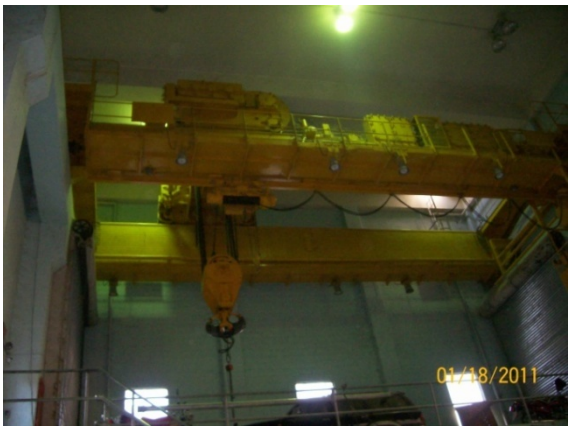
Subsequent observations are noted as follows:

- Travel time for the crane with no load from the loading bay to the lowest level of travel at the Turbine #2 location was observed at 17 minutes each way for a round trip cycle time of 34 minutes.
- The hook also was only able to get within 6 m of the floor. There is limited head room on the loading floor to allow long slinging of loads destined for the lower levels and loads may have to be placed on the Turbine floor level and be re-slung before being placed at the lower levels

The serial number on the crane was found in two locations. One is cast into the trolley and the other was found on the information plate located near the operator's chair. The serial number is C24450T and can be seen in the photo below:

Crane serial number C2440T noted on trolley.

Some representative photos of the crane can be seen below.



Overall view of the crane at the west end of the powerhouse.

Operator's cab is near the north wall.

Main sister hook is rated 115 M tons.

The 115 M ton capacity of the main hoist is cast into the metal of the sheave block.

The auxiliary hoist operation was witnessed on Jan 19, 2011. The capacity of this hoist can be seen marked on the sheave block as 2,000 kg.

It appears that the crane cable has been well maintained. It appeared to be adequately lubricated.

The maker of the electronic equipment and controls for the crane is Cutler Hammer.

Recommendations

The crane was witnessed in operation and appeared to be in serviceable condition; however there was no log book of crane maintenance available. It is recommended that a regular maintenance program be developed to comply with ASME B30.2-05 and a log book be kept to track maintenance operations. An Operations and Maintenance Manual should be obtained from the crane manufacturer and kept in the power house at all times.

When the crane was inspected, it was noticed that the corrosion preventive coating has deteriorated in some places. It is recommended that the crane, rails and all associated metallic parts be cleaned of all corrosion and then recoated.

Before construction of Unit 2 is started, a full crane inspection should be performed complying with ASME B.30.2-05 by a licensed crane inspector. This was subsequently done in 2012, by a licensed Inspector from Dubai. His report shows that the crane is in good and acceptable condition. But the following items have to be cleared, prior to it being certified for operation.

1. The brake oil has to be changed
2. The electronic stop switch on the small hook has to be changed. Because it is not functional, the hook is allowed to travel too high.
3. A full proof-load test has to be applied which will involve the import of suitable water bags to serve as a test load.

It was recommended that a load test of 115 tons plus 10% be performed. This would ensure lifting in compliance with manufacturing specification. The crane will be required during construction of Unit 2. Following construction of Unit 2, yearly inspections are recommended.

In September 2013 the bridge crane was serviced and minor repairs made, including repair of cracked welds on the trolley rails. In October 2013 a complete inspection was performed of the bridge crane, load tests performed and Safe Working Loads certified for the main hoist (95 Tons) and auxiliary hoist (1.36 Tones). To determine the certified load capacity, the crane was progressively loaded with water bags. The bridge crane transverse movement stopped working at 101.8 tons and the cable and hook operation stopped working at 102.5 tons. The water load was maximized to 105 tons and then reduced the weight slowly. The cable and hook normal operation came on at 102.5 tons and the traverse movement came back on at 101.5 tons. Safety Marine determined that the 101.5 tons was the max allowable load and then used a formula to determine the maximum working weight and that was 95 tons.

This reduction in main hoist capacity from 115 tons to 95 tons should be noted to Unit 2 installation contractor but should not be an issue as the largest component to be lifted for Unit 2 installation is 32 tons.

4.3.17 Condition of Quarry/Crushing Plant/Concrete Batch Plant

The aggregate stockpiles, batch plant, and crusher are located outside the Kajaki camp area. It is about a 20 minute commute over bad road by vehicle with PSD escort to get to the site. The bridge over the Helmand River that must be crossed to get there is rated at only 10 tons. The bridge is of wooden construction with a wooden plank drive path. Local knowledge indicates that this road has IED potential. Prior to visiting the site, a scout team was sent ahead to check for IEDs.


Views of the wooden bridge with a wood drive path. Some of the wooden structure is severely deteriorated.

Three samples were taken from three different stockpiles of aggregate. All three sources appeared to have been taken from the river bed as it appeared to be mostly smooth, well rounded, river-washed rock. The aggregate size ranges from approximately 2 to 4-inch in size. The samples were submitted to a testing laboratory to determine if the material is suitable for use in the construction activities for Unit 2. The total volume of all stockpiles is approximately 4,900 cubic meters. Test results indicate the aggregate is acceptable for concrete use and is not reactive. Test results are presented in Appendix 15.


These photos are of the first stockpile from where samples were obtained (approximate volume is 858 cubic meters.)


These 2 photos are of the second stockpile from where samples were taken (approximate volume is 2,420 cubic meters.)


These 2 photos are of the third stockpile that samples were taken from. This stockpile is nearest to the batch plant (approximate volume is 1,625 cubic meters.)

Upon inspection of the batch plant and the crusher, it can be concluded that they are both unusable. The batch plant appeared to be very rusted and deteriorated. The equipment has been riddled with gunfire, as many holes were found throughout. In any case, it would require extensive work and expense to get the machinery up and running. The crusher plant was also in a severely deteriorated state. It was rusted and also had multiple gunshot holes in its hopper. The conveyor belt from the hopper is completely gone and its rollers were rusted to the point that they would not roll freely.

Views showing the condition of the batch plant. The aggregate bin has many holes and is severely rusted.

Recommendation

Contractor provides new crushing plant and concrete batch plant for construction, located on the powerhouse side of the river.

Due to the situation with the bridge, it is felt that the stockpiled aggregate will not be used as it would need to be transported over the bridge. A batching plant and crusher should therefore be located on the powerhouse side of the bridge and a new source of aggregate material be investigated. Potential alternative aggregate sources would be rock from the river bed adjacent to the plant site and/or limestone aggregate from the new substation grading.

4.3.18 Construction Water Sources

The Helmand River below Kajaki Dam, the Kajaki Reservoir, and the existing well at the Kajaki camp were identified as potential water sources for construction purposes, specifically for batching concrete. Water samples were taken from all three sources for testing. Initial water test results for all three sources are included in the Laboratory Testing Report in Appendix 15. Subsequent to the initial testing, USAID requested two additional tests for the river water. These test results will be provided when they are available.

4.3.19 Power Intake Gate

The Unit 2 penstock will be connected to the existing Kajaki HPP penstock system. This system originates with the inclined Power Intake structure on the shore of the Kajaki Reservoir. Water to the powerhouse enters the Intake Structure and passes through the power tunnel to concrete plug in the

tunnel where the steel penstock pipe to the powerhouse begins. The steel penstock trifurcates in the plant yard outside the tunnel. Each of the three branches serves an individual unit. The branch to Unit 2 is stubbed off inside the powerhouse with a dish bulkhead. To tie in the new Unit 2, the dish bulkhead must be removed and a spool piece welded in to connect the penstock to the turbine inlet valve. The spool piece is part of the existing GFE on site. The tie in task is described in the KHPP Unit 2 Installation subcontract package.

In order to complete the Unit 2 tie-in, the existing tunnel and penstock must be dewatered. The only way to shut off and isolate the penstock from the reservoir is to close the existing power intake gate. Dewatering the penstock will force an outage of Units 1 and 3 for the duration of the tie-in task. This total plant outage must be carefully coordinated with DABS.

While not a part of the GFE assessment, it was recognized that the ability of the gate to close and seal was critical. Subsequent to the hydro assessment on site, KHPP commissioned an inspection of the Intake Gate Hoist located on the Intake Structure as part of a broader inspection effort which also included the powerhouse overhead bridge crane and the powerhouse draft tube gate hoist. Review of existing drawings indicates the gate is a roller gate, 14 feet wide and 33 feet high, with rubber seals. The existing gate drawings and plan and profile drawings of the existing tunnel/penstock system are included as Appendix 25.

In October 2012, Lloyds British Ltd. performed the inspections. Their report is presented in Appendix 26. Specific to the Intake Sluice Gate Hoist, Lloyd's examined the hoist and electrical and control panel. Lloyd's did not go into the water and consequently, did not inspect the gate itself or the gate side guides or sill. As noted in the report the gate has not been operated in some time. Whether it is "stuck" in an open position or cannot be operated due to the hoist and/or controls is not clear. The Sluice Gate Hoist is the third item in the report (see pages 19-24 for report findings and photos.)

Recommendation

It is recommended that a complete inspection of the intake gate system, including an underwater inspection of the gate, gate seals, and rails, and any required repair be added to the CM-AR contractor's scope. The intake gate must be serviceable in order to isolate the powerhouse penstock such that the Unit 2 penstock can be tied into the existing trifurcated plant penstock system. This tie in can be deferred until late in the Unit 2 installation process. However, due to the possibility of needing to ship existing components off site for repair or replacement or identification of replacement parts which my take a significant amount of time to be delivered, the inspection of the intake gate should be an early activity of the CM-AR contractor. The actual repair work could be done by the CM-AR or included in the CM-AR's Unit 2 Installation Subcontractor's scope.

When the tunnel and penstocks are dewatered, it is also recommended that the opportunity be utilized to fully inspect the tunnel to assure there has not been any damage to the tunnel from plant operation or the dewatering activity.

It is noted that a complete plant outage will be required during the underwater inspection for diver's safety. Flow into the intake must be stopped. With no cut off in the tunnel/penstock between the intake and the plant, the only way to do that is to take the units off line. The unit 1 and 3 turbine shut off valves in front of the turbines should be closed to assure that plant operators don't bypass the turbines and continue flowing water through the intake and discharging with the bypass valves. This needs to be factored into the planning.

5.0 REPAIR UNITS 1 AND 3 ANALYSIS AND RECOMMENDATIONS – ADDITIONAL UPGRADES FOR UNITS 1 AND 3 (OUT-OF-SCOPE)

5.1 Overview

In the process of performing the scope of work applicable to Component 6, KHPP has determined additional upgrades to Units 1 and 3, which could significantly improve the reliability and generating capacity of Kajaki HPP. Although out of the scope of required assessment, these improvements were a logical fall out of work within scope and are described in Appendix 16 and summarized in Appendix 17. The costs for these recommendations are included in Appendix 18.

5.2 Summary

The windings of both existing units have reached the end of their service lives. Unit 3 winding has already experienced in-service failure, has been patched and output has been de-rated. More failures are sure to occur.

Units 1 and 3 have experienced vastly more severe service than would normally be expected from a stable system. Normal life of a mid-seventies generator stator would range from 25 to 35 years with the usual starts and stops and minimal unplanned outages. These (Units 1 and 3) generators have performed remarkably well considering their experiences and minimal maintenance. At least one coil (Unit 3?) has been cut-out and is decreasing that unit's capability during high temperatures. Further damage is likely to occur if these stators are not replaced as rapidly as possible. Stability of the transmission system is required to even nurse them along for another 2 years. Early operation of Unit 2 will likely result in additional short outages that will stress these units even further. Upgrading of the current break-down maintenance is also necessary in order to identify current conditions. As a minimum, lube oil sampling should be performed annually when unit clean-up, brush work, and measurements are taken. Specific means of oil sampling must be installed as well for the generator bearing systems.

Governor operation is sluggish and is presently causing the units to experience unnecessary detrimental over-speed conditions. Subsequently, USAID approved upgrading the existing Units 1 and 3 mechanical governors in addition to the previously approved upgrades to the Units 1 and 3 governor control panels and PLC's. These tasks are included in KHPP's Kajaki Unit 2 Installation subcontract package.

Additional power will not result from generator rewinds or governor upgrades.

Unit 1 turbine had significant vibration. Subsequent to the site assessment the turbine was inspected. The cone normally attached to the bottom of the runner was missing. This cone allows aeration into the pressure zone below the runner to mitigate vibration. Both Units 1 and 3 underwent rehabilitation in 2009. Unit 3 has the runner cone. It is not known why the Unit 1 runner does not have a cone. In late 2012 KHPP procured and installed the Unit 1 turbine runner cone. This cone installation has greatly reduced the vibration in Unit 1.

As the vibration appears to have been due to draft tube surging which the new runner cone has mitigated, any further analysis of unit vibration is no longer required.

Appendix 22 presents a cost estimate for the original KHPP contract scope of installing Unit 2 and Units 1 and 3 control system upgrades. Estimated direct costs for the recommended Out of Scope improvements to Units 1 and 3 is included in Appendix 18-Cost Estimate-total Project including Units 1 and 3 Out of Scope Upgrades. It is unknown which of these improvements will proceed. It has been assumed they would be performed concurrently with the Unit 2 work as shown on the schedule. Therefore, no additional indirect costs have been applied in Appendix 18.

6.0 MATERIALS TRANSPORTATION PLAN

A Materials Transportation Plan is being developed at the project level to support camp development, operation and construction at the Kajaki site for the duration of the project. A specific Material Transportation Plan for the hydro plant work outlining number and type of trucks and mobile equipment will be described in this section. Timing and grouping of material and equipment transportation will be coordinated with the broader project level transportation plan. The Materials Transportation Plan is a dynamic document which continues to evolve as the overall project definition evolves. The version included in this report was current at the time the Draft Final report was submitted.

Materials Transportation Plan, Rev. 6, dated August 26, 2011, is presented in Appendix 19.

7.0 SUMMARY

7.1 Components Requiring Replacement

Components requiring replacement for Unit 2 and Units 1 and 3 upgrades in original scope are noted in Appendix 20.

The source of replacement parts will be determined during procurement. Original equipment manufacturers (OEM) would be preferred; however the OEM sourcing will require USAID approval.

Where appropriate, replacement items would be factory tested and certified in the presence of an inspector prior to shipment. Some items could be tested on site. Mil specs for raw materials would be specified and reviewed.

A summary of recommended replacement parts and materials is presented in Table 7-1.

Note: The cost for Units 1 and 3 additional out of scope work has not been estimated as standalone activities. The difference in the project cost estimate between Appendix 18, Total Project Cost including Units 1 and 3 Additional Out of Scope items and Appendix 22, Unit 2 and Units 1 and 3 Upgrades, represents the effort to execute the additional Units 1 and 3 out of scope concurrent with the remainder of Unit 2 work. If the additional out of scope Units 1 and 3 work is not executed concurrently with Unit 2, additional indirect costs will be incurred for project support costs such as security, life support, construction management, etc.

Table 7-1 List of Recommended Replacement Parts

Ref	Section	Item
4.3.1 Turbine		
3.	Spiral Case and Head Cover	Replace turbine head cover bolts
12	Inside of Turbine	replace 65 gallons coal tar epoxy
4.3.2 Governor		
1.	Upgrade	Replace Unit 1 and 3 governors with new digital governors
2.	Operation	Supply necessary software.
4.3.3 Inlet Valve		
2.	Motor and Valve	Replace Inlet Valve by-pass valve motor operator and hand wheel operated valve
3.	Seals	Replace rubber O-rings
6.	Flange bolts	Replace flange bolts
7.	Hydraulic control module and connecting hose	Replace hydraulic control module and connecting piping
4.3.4 Auxiliary Mechanical Systems		
4.	Fittings	Pipe fittings
5.	Flanges	Replace 7 weldable flanges
6.	Flanges	Replace 26 flanges
7.	Flanges	Replace 3 flanges
4.3.5 Generator and Auxiliary Equipment		
5.	Air coolers	Replace 8 air coolers
9.	Paint	Replace paint materials for winding, rotor, rotor lead
13.	Thrust Bearing Runner	Replace thrust bearing runner (rotating plate)
16.	Stator	Replace 150 stator bars
17.	Thrust Bearing Insulation	Replace thrust bearing insulation
18.	Paint	Replace 65 gallons epoxy paint
4.3.8 Generator Switchgear		
1.	Switchgear	Replace 13.8 kV switchgear with arc-resistant unit
2	Circuit Breakers	Include additional in-place spares
3.	Breaker	Replace with arc-resistant unit
4.	Breaker	unit

Ref	Section	Item
5.	Breaker	Replace with arc-resistant
6.	Breaker	Replace with arc-resistant
7.	Breaker	Replace with arc-resistant
4.3.10 Main Transformers		
9.	Oil	Mobile oil processing unit required
4.3.12 Station Auxiliaries		
2.	Cable	Replace 65 cable termination kits
3.	Cable	Replace stress cones and self-vulcanizing tape
4.	Cable	Replace 800 meters
5.	Cable	Replace 50 meters
6.	Cable	Replace 300 meters
7.	Cable	Replace 400 meters
8.	Self-Cleaning Cooling Water Strainer	Replace strainer drive motor, differential sensor, auto dirty water drain controller
9.	Self-Cleaning Cooling Water Strainer	Replace strainer drive motor
10.	Batteries	Replace 20 ea.-12 Volt
4.3.13 Station Service Modifications		
2.	Isolation switch	Replace 13.8kV dual source switch
4.3.14 Loose Materials		
1.	Loose Materials	O-rings, rubber gasket material, turbine shaft seal packing, etc.
2.	Reeled cable	Electrical Cable
4.3.17 Crushing Plant/Concrete Batch Plant		
2.	Plant	New crushing plant and concrete batch plant for construction
Boring Bar		
N/A	Unit 2 Installation Equipment	Boring Bar

Replacement costs for all components are included in the revised project cost estimate in Appendix 18, revised for the Final Report.

7.2 Components Requiring Repair

Components requiring repair are also noted in Appendix 20.

Recommended repairs are summarized in Table 7-2.

Repair costs for all components are included in the revised project cost estimate in Appendix 18, revised for the Final Report.

Table 7-2 Kajaki List of Repair Parts – Unit 2

Ref	Section	Recommendation	Repair	Remarks
4.3.1	**Turbine**			
4.	Bottom Ring	Item #22 -Wicket gate self lubrication bushings cleaned and checked	Re-use	
5.	Tank	Item # 133 – Certification for governor oil cushion tank	Re-use	
6.	Main Inlet Valve	Item # 159 – Counterweight clean and paint	Re-use	
7.	Operating ring	Item # 307 – clean and paint	Re-use	Replace one bronze wear pad on bottom interior of Operating Ring. Pad has been damaged in handling. Self lubrication bushings need to be cleaned and checked
8.	Pressure Relief Valve	Item #317 -Lubrication	Re-use	
9.	Draft Tube	Draft tube sections build to the pit concrete wall. There are no steel liners on site for lining the two concrete discharge passages (about 16 ft. long each) to the tailrace. Sand blast and resurface	Re-use	
11.	Spiral Case Sections	Item #349 – sand blast and recoat	Significant modification (machining, tapping, and re-coating) required in field; re-use	Bottom of spiral case base is noticeably warped. Needs to be evaluated and corrected at time of installation. May affect the fit of the bottom ring.
4.3.2	**Governor**			
3.	Unit 2 Governor air receiver	No ASME or National Board stamp. Stamp required? Acceptable without?	Re-use	Replace if stamp is required

Ref	Section	Recommendation	Repair	Remarks
4.	Control Cabinet	Air receiver and oil reservoirs on governor control cabinet should be internally inspected	Re-use	
4.3.3	**Inlet Valve**			
1.	Valve Stem	Field repair cracks in valve stem cylinders	Repair	Welding procedure required.
4.	Flanged Section	Item #160 – Clean and paint	Re-use	
5.	Flanged Section	Item #161 – Clean and paint	Re-use	
4.3.4	**Auxiliary Mechanical Systems**			
2.	Lube Oil	Test to confirm if Type 1 or Type 2		There is no lube oil on site for Unit 2. There is no lube oil listed on the GFE. All oil found is transformer insulating oil.
3.	Oil Storage	Create a dedicated oil storage space (room)—use bladders for oil storage rather than barrels		Recommendation to facilitate O&M. Not included in cost estimate.
4.3.5	**Generator and Auxiliary Equipment**			
1.	Stator slot wedges	Clean the winding	Repair	
2.	Stator	Re-wedge the stator	Repair	A supply of replacement wedges will be needed due to breakage of some of the existing wedges during re-wedge. Will also need some slot fillers for same reason.
6.	Flanges	Item #6 – Flange cleaning required	Repair	
7.	Insulation	Item #26 – Insulating Hardware tightened	Re-use	
8.	Bus sections	Item #166 – Replace 5 bus sections	Fix and reuse	
10.	Field Poles	Item #313 – 6 field poles disassembled and cleaned	Re-use	And tested

Ref	Section	Recommendation	Repair	Remarks
11.	Field Poles	Item #314 – 6 field poles disassembled and cleaned	Re-use	And tested
12.	Field Poles	Item #315 – 6 field poles disassembled and cleaned	Re-use	And tested
15.	Winding	Item #351 – Winding cleaned and stator re-wedged	Re-use	
19.	Collector Ring	Item DF3-54/90 Not in Inventory – Clean rust from collector ring	Clean and re-use	
4.6.6	**Excitation System**			
	None		N/A	
4.3.7	**Generator Neutral Cubicle**			
	None		N/A	
4.3.8	**Generator Switchgear**			
	None		N/A	
4.3.9	**13.8 kV Non-Segregated Phase Bus Duct**			
1	Bus Duct		Re-use	All bus duct sections have been located and are serviceable.
4.3.10	**Main Transformers**			
1.	Locations	3 on site, 4th originally at Kabul, since moved to site	Re-use	Accessories for 4th X/F are on site except for one missing “cable box” for LV bushing compartment.
5.	Locations	Control panels	Re-use	All control panels have been located on site and are serviceable.
6.	Conditions	Condition of bushings	Re-use	All bushings and LA’s found and OK.
7.	Locations	Radiators, fans, conservators	Re-use	All fans and radiators have been located and are OK.

Ref	Section	Recommendation	Repair	Remarks
8.	Locations	Wheels for rails	Re-use if appropriate	All wheels and rails have been located. Notes on drawings by reviewers indicate that the wheels should not be installed. Wheels will raise the transformers and may cause problems matching the LV compartment on the transformers with the existing 13.8 kV bus duct.
4.3.11	**Control, Metering, and Protection Boards**			
4.	Additional work	Need detailed field assessment of units 1 and 3 field control and monitoring devices to verify consistencies with unit 2 devices		
4.3.12	**Station Auxiliaries**			
1.	Detailed design	Additional field engineering required for Unit 2 and upgrades to Units 1 and 3 to develop		
4.3.13	**Station Service Modifications**			
1.	Power	Configuration of station service distribution should be re-configured as it now requires either Unit 1 or 3 to be on-line and operating in order to have station service power		System design revised in KHPP Unit 2 Installation package
4.3.14	**Loose Materials**			
3.	List of materials	Need list of quantities and descriptions for loose materials to know if requirements are met		
4.3.16	**Condition of Civil Works/Plant Structure**			
1.	Building	Exterior of building should be re-plastered	Repair	

Ref	Section	Recommendation	Repair	Remarks
2.	Building	Cracked joints be tuck pointed with mortar	Repair	
3.	Building	Investigate anchoring of overhead distribution lines on building		To be performed by third party responsible for new Kajaki substation design
4.	Building	Repair cracking in concrete column	Repair	
5.	Roof	Roof should be sealed and resurfaced	Repair	
6.	Concrete	Unit 2 concrete roughened, cleaned, coated	Repair	
7.	Concrete	Unit 2 remove water existing rebar cleaned, recoated	Repair	
8.	Building	Bolts throughout structure should be inspected		
9.	Roof	Can powerhouse rooftop structure support switchgear equip?		Not needed with new remote 110 kV switchyard location.
10.	Crane	No log book of crane maintenance		
11.	Crane	Regular maintenance according to ASME B30.2-05		
12.	Crane	Need O&M manual from crane manufacturer		
13.	Crane	Crane, rails, metallic parts cleaned and recoated	Repair	Subsequently repaired by KHPP
14.	Crane	Need full crane inspection by licensed crane inspector.		Subsequently inspected by KHPP
15.	Crane	Need load test for crane 89 tons, and yearly inspections		Subsequently load tested and certified to 95 tons by KHPP
4.3.18	**Power Intake Gate**			
1.	Intake Gate	Need inspection of power intake gate and dewatered tunnel		Added to Amended Final Report

7.3 Loose Materials

Due to lack of detailed packing lists or material quantity take-offs, it was impossible to completely inventory or determine condition of loose materials. Worst case would be for KHPP to perform a detailed material take-off from the design drawings of the loose materials, such as cable and miscellaneous piping, and assume total replacement unless these materials can be accurately inventoried in a future site assessment.

7.4 Long-Lead Time Items (Amended – 9 December 2013)

Table 7-4, Long Lead Time Items – Unit 2 indicates those items with expected cost which Black and Veatch identified as long lead time items which B&V initially recommended to USAID that B&V procure:

Table 7-4 Long Lead time Items – Unit 2

Item #	Long Lead Time Item	Final Cost	Market Cost Estimate
1	Turbine Head Cover Bolts	[redacted]	[redacted]
2	Governor Software / PLCs	[redacted]	[redacted]
3	Air Coolers and Gen. Aux. Equip.	[redacted]	[redacted]
4	Gen. switchgear and Circuit Breakers	[redacted]	[redacted]
5	Inlet Valve Bypass Motor-operated Valve and Hand Wheel operated valve	[redacted]	[redacted]
6	Cable Package	[redacted]	[redacted]
7	Self Cleaning Water Strainers	[redacted]	[redacted]
Total		[redacted]	[redacted]

During the process of the tender release and review of returned bids for Unit 2 construction it was determined by B&V that it made more sense, due to needs for compatibility and integration of equipment, if the construction subcontractor procured items # 2, 3 and 4. An assessment was undertaken to ensure that the procurements could occur within the needed time frame to meet the construction schedule.

B&V proceeded with the procurements of items # 1, 5, 6 and 7 and has included these items in the updated Joint Inventory provided in the Amended Appendix 11and 12.

8.0 SCHEDULE

8.1 Executive Summary

This section is intended to provide a Basis of the schedule for all known items related to installation, testing, and commissioning of the Kajaki Unit 2 hydroelectric turbine generator and all known related scope necessary to enable operational capability of Unit 2 and perform the control upgrades to Units 1 and 3. Work includes repairs/improvements to Units 1 and 3 as identified in Component 6 and camp upgrades/repairs required to support the staff necessary to complete the Unit 2 work. The known work has been identified in the assessment report.

The original schedule was submitted with the Draft Final Report in August 2011. Following review meetings with USAID, the schedule was revised and shortened for the Final Report in January 2012. The revised schedule has been based on total project duration of 34 months and the construction duration of 22 months. The Level 2 schedule is presented in Appendix 21. The schedule has not been updated for the Amended Final Report.

KHPP is not aware of a single generation, transmission or distribution project by any entity in Afghanistan that has met its original schedule without significantly higher costs and total military protection being applied. The schedule indicated in the report reflects the review of various projects undertaken within Afghanistan and KHPP's experience in Afghanistan. It would be possible to reduce schedule if productivity rates for all labor are assumed to equal those applicable to US utility work.

8.2 Major Schedule Components

8.2.1 Assessment Report/Procurement/Engineering

The Black & Veatch schedule dated 11 November 2011, is based on the Final Inventory and Condition Assessment Report.

Engineering

The engineering period covers both preparation of replacement equipment specifications for procurement and detailed design for the construction package. As shown on the schedule, these activities are concurrent.

As described in report, CMIC design is not complete. B&V review of Outstanding MWH review comments on both CMIC design and shop drawings must be authorized, once authorized, they can be evaluated and resolved. Then design can be completed. Electrical and control design was acknowledged by Government in the RFP as not complete. Also, some structural design is required. An example is CMIC Drawing KAJK-PH-01-E, noted as Approved As Revised (AAR). This drawing has open review comments relating to electrical and structural issue.

The Engineering effort assumes electronic CADD files of the existing CMIC Design are delivered by USAID to KHPP at Notice to Proceed (NTP) for Subcomponents 6.2 and 6.3 per Contract Attachment 10 – Technical Specifications, Section GS-2.7. If KHPP is required to recreate the existing design drawings, additional time and cost will be required and are not included in this schedule or the estimate. However, if electronic drawing files are not available, it is estimated that one additional month and [redacted] of technician labor and potential extended overhead costs, would be required to replicate base drawings.

Engineering efforts are schedule on a normal USA work calendar of 8 hours per day, 5 days per week.

The Home Office Engineering support is shown in Appendix 18 under Program Support and totals 2,010 man days. For cost estimating purposes, it was allocated against the six positions shown in the estimate table. However, the Home Office Engineering Support is the design and engineering support of procurement through the award of equipment procurements and the construction package. It will be expended during the 7 month engineering period shown on the schedule. This level of effort (1,650 man days) translates into 12 Full Time Equivalents (FTE's). Post award support from Home Office (360 man days) will be provided to support the field engineering staff identified in the staffing plan in Appendix 18.

Regarding schedule, some schedule compression is possible but limited due to the startup time required to complete detailed review of existing documents, resolve outstanding design questions from the previous CMIC design and multiple AID design reviews. Considerable review was done by KC staff and assessment team in preparation for the onsite assessments and getting familiar with the project to estimate effort. This is how B&V identified gaps described in the report – design and shop drawings still AAR, electrical design, some structural design in powerhouse.

The Staffing Plan in Appendix 18 represents the Field Staffing Plan. It includes Field Engineering support beginning at contractor mobilization in late 2012. The Home Office Design Engineering effort is presented in Appendix 18, Cost Estimate.

Procurement

Procurement durations are based on normal USA work calendar of 8 hours per day, 5 days per week. USAID review and approval of Request for consents are assumed to occur in 6 work days.

Bridge Crane Certification

Certification of the existing bridge crane is required prior to its use. This will require early mobilization of some field staff in addition to third party technicians

8.2.2 Units 1 and 3 – Electrical & Control Upgrades

Schedule includes electrical and control upgrades as identified in the supplied GFE.

8.2.3 Units 1 and 3 Common Plant Upgrades

During the installation of the common plant upgrades, a long entire power plant outage is required on all units to connect new common plant switchgear. The penstock in the tunnel and through the trifurcations to the powerhouse will need to be drained in order to accomplish the tie-in of the Unit 2 Penstock. Plant/OPS can drain the penstock in 14 days for the tie-in connection of the Unit 2 Penstock.

8.2.4 Unit 2 – Installation & Commissioning

- Limestone rocks located on the north side of the dam can be used as aggregate. If local rock is unsuitable for concrete aggregate, then both schedule and cost estimate will require revision.
- Overhead crane will be available for construction work on a full-time basis.
- Concrete placement durations include formwork, rebar installation, concrete placement, and cure time.
- Civil Subcontract
    - The estimate for civil work includes all known civil work required for camp improvements, site access and Unit 2 construction to include procurement and shipping of required materials. Quantities for Unit 2 work are based on the existing design drawings provided by USAID. Quantities for camp improvements are based on a list of requirements that was developed by the assessment team and the number of additional housing units and other facilities required to support the projected population. It was assumed that DABS will provide free access to the entire facility and all equipment, including support of numerous required shutdowns of turbines 1 and 3.
- Unit 2 Installation Subcontract
    - The schedule for the Unit 2 installation subcontractor work includes all known Civil, Mechanical, and Electrical work (as identified in the assessment report under SubCLIN 6.1) required for Unit 2 construction and Units 1 and 3 improvements to include procurement and shipping of all materials and equipment. Quantities for Unit 2 work are based on the existing design drawings provided by USAID. It was assumed that DABS will provide free access to the entire facility and all equipment, including support of numerous required shutdowns of turbines 1 and 3.

8.3 Assumptions

8.3.1 Contracting Method

Black & Veatch will perform all of the engineering, design, and procurement of replacement parts. Construction work will be subcontracted. The schedule was prepared based on a civil subcontractor for camp improvements and a Unit 2 civil/mechanical/electrical subcontractor both of which are directly subcontracted to Black & Veatch with the Unit 2 sub acting as the general contractor.

8.3.2 Work Hours

The construction schedule is based on subcontractors working 6 - 10 hour work days per week. Engineering schedule is based on working 5 – 8 hour work days per week. Procurement schedule is based on working 5-8 hour work days per week.

8.3.3 Productivity

Craft labor productivity for the turbine work is based on productivity rates for southeastern U.S. adjusted to 50% productivity based on previous experience and the expectation that productivity will be lower due to working in an existing power house facility. Rate for other work are based on U.S. average productivity adjusted to 50% for Afghanistan.

8.3.4 Helicopter Transport

Helicopter transport will be required for safe transport of personnel to and from site during mobilization/demobilization and for R&R travel in addition to provision of critical items on an as-needed basis. An allowance is also included for medical evacuation trips.

8.3.5 Mobilization/Demobilization

It was assumed that all craft will be transported to and from site via surface transportation. All Black & Veatch Staff and subcontractor management staff are assumed to be mobilized via helicopter transport. It was assumed for the purpose of the schedule that the road from Kandahar to Kajaki will be open for safe transport of materials for a period to be agreed to prior to the start of construction and throughout the duration of construction.

8.3.6 Material Shipments

All material and equipment shipments, including regular shipments of food and fuel, were estimated on the basis of land transportation. It was assumed for the purpose of the schedule that the road from Kandahar to Kajaki will be open for safe transport of materials for a period to be agreed to prior to the start of construction and throughout the duration of construction.

8.3.7 Man-Camp

Man-Camp requirements are based on the construction of a separate subcontractor camp for CLIN 6 subcontractors and the construction of additional facilities and infrastructure required in order tosupport Black & Veatch CLIN 6 personnel. The subcontractor camp estimate is based on 120 TCN/CCN and 10 expats. The additional facilities for the BV Camp are required due to expected overlap between CLIN 5 and CLIN 6. It was assumed that all other required upgrades to the existing man-camp will be

completed under CLIN 5 prior to field mobilization for CLIN 6. All man-camp facilities will be left in place upon completion of the project.

8.3.8 Unit Outages

The defined scope for CLIN 6 includes installation of Unit 2 and upgrades to Units 1 and 3 control systems. Careful planning and execution of the work related to Units 1 and 3 will be required and must be closely coordinated with Unit 2 installation due to the limited laydown space available inside the power house and competition for use of the overhead bridge crane. Work at the powerhouse must also be coordinated with completion of the new substation under CLIN 5.

Four potential outages have been identified and are described below.

1. Hydraulic tie in of Unit 2 penstock. In order to connect Unit 2 to the plant penstock, a plant outage will be required. The outage will require draining the power tunnel and penstock to the powerhouse, cutting off the existing cap on the Unit 2 penstock, aligning and welding in the new penstock transition section, connecting the new section to the turbine inlet valve, testing all connections and rewatering the entire plant penstock system. Note that the inlet valve hydraulic system including the servo needs to be in place to ensure the integrity of the inlet valve since it will become a clearance (lockout tag out) boundary. This might take more time if it can't be done concurrently with the other work.

Water is supplied to the plant by a tunnel from the reservoir intake structure to the plant. The tunnel from the reservoir to a concrete plug located about halfway down the tunnel is unlined. The tunnel downstream of the plug is fully lined. The penstock is exposed pipe from the concrete plug to the end of the tunnel where it goes underground across the driveway to the plant. Since there are no intermediate shut off points between the reservoir intake structure and the plant, the entire tunnel must be dewatered to isolate the plant. KHPP has conservatively estimated the time for draining the tunnel to avoid risk of rock failure in the unlined portion of the tunnel.

It is estimated that a two week plant outage is required to complete this task. This is less than the total of 8 weeks shown in the preliminary schedule and assumes the tunnel and penstock can be drained with no complications in 3-4 days. This also assumes that all required materials and equipment have been staged on the Turbine Inlet Vale floor and the penstock support saddle had been constructed.

2. GSU Transformer Replacement. The three single phase GSU transformers are to be replaced. The plant must be shut down while all three transformers are replaced. The transformers are on site but must be dressed out by installing radiators, conservator tanks, and HV and LV bushings. The LV bushings are bottom connected. We are assuming that the bushings can be bolted up without draining the oil below the transformer windings. If not, additional equipment will be required on site and additional time is required to vacuum dry the transformer tanks and then

refill them. It is also noted that the main conductors (which are anchored to the powerhouse wall above the transformers) from the transformers to the substation will be replaced under CLIN 5. So, the new substation must be completed before the transformers are replaced.

It is estimated a minimum four weeks plant outage is required to disconnect and remove the existing transformers, set them, dress them out and reconnect them.

3. 13.8 kV Generator Switchgear Replacement. The originally supplied switchgear for Unit 2 is being replaced with new switchgear. The existing switchgear for Units 1 and 3 will be also be replaced and integrated with new switchgear for Unit 2. Bus to the transformers must also be replaced for the new switchgear configuration. To minimize outage duration, all new equipment and materials must be pre-assembled and staged near the existing switchgear in the powerhouse.

It is estimated a minimum four week plant outage is required for this task.

4. Units 1 and 3 Governor Replacement. The existing governors on Units 1 and 3 are to be modified with electronic components. The new components are on site. The units can be upgraded individually such that only one of the two existing units is off line at any given time. Work in each unit involves removing the existing main valve and controls from its cabinets and installing the new controller and valve inside the existing cabinet.

It is estimated a 2-3 week outage would be required for each unit. This schedule assumes no pressure or piping changes or other modifications to the existing mechanical equipment.

These estimated durations assume careful planning and staging of materials and equipment prior to each outage. It also assumes adequate resources of qualified, experienced personnel.

Minimum outages are summarized as follows:

1. Hydraulic tie in of penstock	2 week plant outage
2. Transformer replacement	4 week plant outage
3. Switchgear replacement	4 week plant outage
4. Unit 1 and 3 Governor replacement	3 week outage per unit

The preliminary schedule shows all of these tasks, plus completion of the Unit 2 installation, occurring concurrently in a 4 month plant outage. The longest single task is estimated to require a minimum of four weeks. It would be optimistic to assume that all three common tasks and the governor replacement for either Unit 1 or 3 could all be accomplished concurrently with Unit 2 completion within the minimum window for one task.

These tasks can be viewed somewhat independently of one another. However, when these tasks are

separated in schedule, multiple outages would be required. For instance, the hydraulic tie in of the Unit 2 penstock is independent of the other tasks and is required only for Unit 2 installation but requires a complete plant outage. It could be scheduled earlier in the construction period. If scheduled earlier, this would entail two complete plant outages (one for the penstock tie in, second for the transformer and switchgear replacement), but would relieve the compact schedule at the close of the work. The penstock installation must follow the spiral case installation.

The transformer and switchgear replacements are coupled to each other but independent of the other tasks.

The Unit 1 and 3 governor modifications are independent of the other tasks and could be scheduled earlier in the construction period.

This outage schedule discussion addresses only the work identified above. It assumes that the station service distribution issue will be resolved. At this time, they have not been totally resolved. This outage discussion does not address recurring outages or outages for installation of new equipment if such installation cannot be coordinated with one of the above outages.

This schedule does not directly address additional outages for Units 1 and 3 which would be required for implementation of any of the proposed additional upgrades to Units 1 and 3 identified in the report.

8.3.9 Startup and Commissioning

Startup, commissioning and training requirements are included in the Unit 2 Installation subcontractor estimated scope. In addition, Black & Veatch startup personnel and startup consumables are included. It was assumed that DABS will provide free access to the entire facility and all equipment, including support of numerous required shutdowns of turbines 1 and 3 and of commissioning activities.

8.3.10 Project Schedule

The schedule is based on total project duration of 34 months with construction duration of 22 months.

8.3.11 Other Assumptions

The current amount of security personnel and equipment provided by Black & Veatch is adequate and subcontractors will not need to provide any additional security personnel or equipment.

Shipping costs are based on current quotes which are contingent on a secure route (secured by the U.S. or other NATO forces) from Kandahar to Kajaki with only standard convoy security escorts required. Any deviation from this assumed condition would result in dramatically increased transport costs, possible schedule delays and would likely make transport of much of the equipment impossible. The schedule does not include any anticipated security related delays in transportation, labor deployment, or material deliveries.

It was assumed that subcontractors with the skills and experience necessary to do the work are available and willing to work in this location. If the contracting community proves unwilling to work in this area or

contractors with the right skills cannot be found in the region, costs and schedule will likely significantly increase due to the need to provide extra financial incentives, security or other concessions.

KHPP assumed that minimal or no support will be provided by plant personnel, with the exception of providing cooperation for access to equipment and accommodation of required outages.

It was assumed that the U.S. military would remain in place at Kajaki and provide a secure perimeter as is currently the situation. Should this situation change, the estimated cost would not be valid and it may not be possible to successfully execute the project.

It was assumed that the security situation at the site will be no worse than the current situation for the duration of the project.

It was assumed that KHPP will be able to continue the use of their current private security contractor for the duration of the project.

It was assumed that road access to the site will be provided in time to meet the proposed schedule. In addition, it was assumed that the work from Component 5 will be able to commence according to the current schedule in order to avoid the need for a larger camp facility.

Construction and material escalation will remain level and will not exceed the amount of escalation applied in the estimate. Escalation greater than estimated will result in costs that exceed the current estimate.

Estimated design effort is based on the following assumptions:

- All of the original design documents will be provided to KHPP in native CADD format.
- KHPP will provide design submittals for review at the 50% and 100% .
- KHPP will not provide detailed rebar fabrication drawings.
- KHPP will cross check dimensions provided on CMIC or GFE drawings with design drawings. Field checking of dimensions will be done by the Unit 2 subcontractor.

Note: The original Kandahar Helmand Power Project scope for BVSPC included both the hydro plant installation and the new Kajaki substation. The schedule for the hydro plant installation presented in this report was based on BVSPC performing both projects. Subsequent to completion of this report, design and construction of the Kajaki substation was assigned to a third party. The scope and schedule of the substation work has not yet been determined. In addition upgrades to the irrigation outlet works by a third party are planned at Kajaki HPP. The schedule presented in this report does not address potential schedule extension to the hydro plant installation schedule due to third party substation construction and irrigation outlet work activities concurrent with the hydro plant installation on the

small, congested Kajaki site.

9.0 MAJOR COST ESTIMATE COMPONENTS

9.1 Estimate Accuracy

The individual estimates for this CLIN generally fall within the range of a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International (AACEI). According to the AACEI, a class 4 estimate is one in which the scope definition is between 1% and 15%. A project that is 100% defined would include 100% detailed plans and specifications and all aspects of the project would be 100% defined. According to AACEI's range of accuracy for a Class 4 estimate, these estimates should be within +30%/-15% at the high end of the Class 4 definition scale to +120%/-60% at the low end of the scale.

The original cost estimate was submitted with the Draft Final Report in August 2011. Following review meetings with USAID, the cost estimate was revised and reduced for the Final Report in January 2012. This revised Basis of Estimate and associated cost estimated reflects project planning as of 11 November 2011 and is based on this Final Inventory and Condition Assessment Report. The revised cost estimate summary is presented in Attachment 1 of Appendix 22. Additional backup is provided in Attachment 2 of Appendix 22. The cost estimate has not been updated for the Amended Final Report.

Significant cost reductions were incorporated into the revised cost estimate based on the following:

- Revised assumptions to camp facilities
- Assumption that reliable power is available from CLIN 5 improvements to local distribution, reducing fuel cost
- Reducing construction schedule 2 months
- Changing assumptions that security is covered in CLIN 5 through August 2013

9.2 Black & Veatch Staff

Black & Veatch staffing will be required for home office, program management office, and site which are addressed separately in the following subsections.

9.2.1 Program Management Office

The Program Management Office (PMO) staff will be covered under other components of work until the currently scheduled completion of the various scopes of work under this program. The projected completion date of August 2014 for the Unit 2 work will result in the need to extend a Cadre of PMO staff by 12 months. The costs for the 12 month extension of PMO duration including all support and travel costs expected during this time are included in the estimate for Unit 2.

9.2.2 Site Staff

The required site staff consists of 9 full time expats plus startup staff. A significant core of Black & Veatch staff is required on site due to the technical nature of the project, strict quality control requirements, safety needs, and security concerns.

9.2.3 Home Office Support Staff

Home office staff will be required for management and to provide assistance to in-country staff. Home office staff costs are currently covered under components of work until currently scheduled completion in April of 2013. Unit 2 work will require that home office support be extended by 12 months.

9.2.4 Inter-Organizational Staff

Staff from Black & Veatch's Water Division will be responsible for preparation of design and design support during construction. Costs have been included for Water Division Engineers and Technicians to prepare the detailed design, conduct any required design reviews and provide support to the field during construction to resolve technical issues as they arise.

9.3 Other Direct Costs

Other Direct Costs (ODC's) include items for life support such as camp fuel, equipment maintenance, communications service, IT equipment and other supplies and equipment related to life and project support. The most significant cost driver in this category is fuel needed to provide camp power. The camp fuel requirement is based on the assumption that two camps will be required (the current camp with improvements for BVSPC personnel plus a subcontractor camp). For the purpose of this estimate, it was assumed that current power reliability problems will be repaired prior to mobilization for Unit 2 work which will eliminate the need for the camps to run on full time generator power. Based on the assumption of reliable power availability, the requirement for camp fuel was calculated based on an average 25% load for a 250KW generator at each of the two camps. The fuel requirement calculated is roughly half of the previous Unit 2 estimate due to the assumed availability of reliable power from the local distribution system. Should local power prove to be unreliable, this cost will increase over what is included in the current estimate. Fuel cost used in the calculation was [redacted]/Liter (Rounded to [redacted]/gallon) plus [redacted] in transportation cost for each truck delivery of 4,000 gallons. This equates to [redacted]/gallon delivered. The calculation sheet for camp fuel costs is included in Attachment 2 of Appendix 22.

9.3.1 Security Costs

Estimated security costs are based on the pricing from our pending security contract at Kajaki. The amount of security staff and vehicles on site during the Unit 2 work is expected to remain the same as the current security force. For the purpose of this estimate, it was assumed that security costs would be covered under component 5 through August of 2012 at which point the cost would have to be borne under the Unit 2 work. The security force will consist of 3 Expats, 3 TCNs and 179 local nationals. The calculation sheet for security costs is included in Attachment 2 of Appendix 22.

9.3.2 Helicopter Transport

Helicopter transport will be required for safe transport of personnel to and from site during mobilization/demobilization and for R&R travel in addition to provision of critical items on an as-needed basis. An allowance is also included for medical evacuation trips. The estimate for helicopter service includes only transportation of management staff. It is assumed that all craft laborers and CCN security personnel will be transported to and from the site over land or via helicopter on a space available basis on flights that have extra space. It should be noted that to date, the security situation has required helicopter transport of all personnel to the site. This estimate is based on the assumption that CCN personnel will no longer need to be transported by helicopter on the basis that travel by road will be safe and feasible. Unit pricing for helicopter travel is based on the cost per trip currently being incurred by the program. The calculation sheet for helicopter costs is included in Attachment 2 of Appendix 22.

9.3.3 Bridge Crane Certification

Certification of the existing bridge crane is required prior to its use. This will require early mobilization of some field staff in addition to third party technicians. Costs have been included for this item including recurring annual inspections. The price does not include any repairs, upgrades or refurbishment costs. The calculation sheet for bridge crane certification costs is included in Attachment 2 of Appendix 13. Cost includes technician time and expenses, and providing and transporting testing materials (ballast weights and shipping, etc. makeup approximately [redacted] of total) for testing and certifying the crane There is no capacity within Afghanistan to certify the crane, which meets the Safety contractual requirements within the Prime Contract. The amount included for annual inspections is an allowance of [redacted]/year and is not included in the calculation sheet.

9.3.4 Factory Representatives

An allowance was included for manufacturer representatives for different system components to be on site during installation, startup, and testing of Unit 2.

9.3.5 Insurances

Estimated insurance costs are based on quotes received for the other program components. Builders risk and general liability insurance are priced based on total estimated contract value for Unit 2. Cargo insurance is based on estimated value of cargo.

9.3.6 Camp Services

Estimated camp services costs include the cost of food and food service, laundry supplies and service, housekeeping, camp facilities maintenance, bottled water and other miscellaneous camp life support costs. The estimated cost of camp services is based on historical cost per person for other projects in Afghanistan with a premium applied due to the high cost of transport to Kajaki. Camp services costs are included for both the BVSPC camp and the subcontractor camp. Per person costs for the subcontractor camp are lower due to the expectation of more TCN and CCN personnel. Camp services for the subcontractor camp are based on 10 expats and 120 TCN/CCN. BVSPC camp services are based on a maximum of 32 personnel including security subcontractor expats and subcontractor camp support personnel. Local national security personnel are not included in this item. Camp services calculation

sheets are included in Attachment 2 of Appendix 22.

The proposed approach to camp services is materially different from the current approach being used. Currently, all transportation of personnel and supplies into and out of Kajaki camp is by helicopter, which is very expensive. The KHPP approach described in the assessment report is based on Rout 611 being continuously open, thus significantly reducing the life support costs. Camp services/life support costs for the Kajaki area are significantly higher than in other locations in Afghanistan, due to the high cost of transport.

9.3.7 Civil Subcontract

The amount included in the Civil Subcontract line item includes the following:

- Improvements/additions to the main camp required to house and support personnel required for CLIN 6 only, due to the fact that CLIN 5 and CLIN 6 work will significantly overlap
- Construction of camp for CLIN 6 subcontractor personnel
- Required construction equipment
- Shipping of equipment and materials related to civil work
- Civil subcontractor construction management and construction indirects

The pricing included for the civil subcontractor is based on the assumption that BVSPC will subcontract directly with the civil subcontractor. BVSPC will also provide a detailed scope of work, drawings and specifications for improvements to the main camp. Design will not be provided by BVSPC for the subcontractor camp but general criteria and required camp capacity will be provided to prospective civil contractors. It is intended to leave all camp infrastructure and facilities for both camps in-place upon demobilization from the site.

Details regarding estimated costs included for the civil subcontractor are included in Attachment 2 of Appendix 22.

9.3.8 Unit 2 Installation Subcontract

The estimate for Unit 2 subcontractor work includes all known Civil, Mechanical and Electrical work (as identified in the assessment report under SubCLIN 6.1) required for Unit 2 construction and required Units 1 and 3 improvements to include procurement and shipping of all materials and equipment. Quantities for Unit 2 work are based on the existing design drawings provided by USAID. Subcontractor indirect costs have been included for site management personnel, home office personnel, construction power, scaffolding, small tools & consumables, safety equipment, quality control testing, weather and dust protection, and material handling.

It was assumed that DABS will provide free access to the entire facility and all equipment during

construction, including support of numerous required shutdowns of turbines 1 and 3.

Potential bidders are currently being identified. A recommended bidders list will be provided to USAID when it is available.

Details regarding estimated costs included for the Unit 2 subcontractor are included in Attachment 2 of Appendix 22.

9.3.9 Startup Consumables

Estimated costs for startup consumables were provided by the Black & Veatch power generation startup group. The calculation sheet for startup consumables is included in Attachment 1.

9.3.10 Warranty Allowance

The estimate does not include any allowance for warranty coverage. In the event that warranty work is required, this would be a cost in addition to the current estimate.

Warranty requirements are covered in Attachment 14 of the Contract. Warranty requirements will be imposed on the subcontractors covering the majority of the work. Any equipment that is procured directly by KHPP will be covered by the supplier standard warranty. KHPP will not warranty any GFE, as no third party has been identified to accept his work. Therefore, the potential cost lies with the existing equipment and there is no way to estimate the cost to provide warranty coverage.

9.3.11 Internet

Internet costs are based on current KHPP experience and provider historical costs for satellite internet service of sufficient bandwidth to maintain effective productivity of personnel on site.

9.3.12 Drinking Water

The initial estimate included approximately [redacted] for a package potable RO WTP and additional funds to upgrade or replace the water distribution system. The revised plan is to use existing well as non-potable water source and add on site tanks for storage. Additional funds to upgrade or replace the water distribution system are still included. Potable water will be bottled water transported to site.

9.4 Assumptions

9.4.1 Contracting Method

The estimate was prepared based on a civil subcontractor for camp improvements and a Unit 2 subcontractor, both of which are directly subcontracted to Black & Veatch.

9.4.2 Subcontractor Markups

Subcontractor markups were assumed to be 5% for G&A and 15% for profit.

9.4.3 Craft Labor Rates

Due to the skill sets required and the precise nature of much of the work, the majority of the craft will be skilled TCNs. The labor rates used for craft are based on regional rates for other projects that Black & Veatch is currently performing or has recently completed. The labor rate applied for mechanical trades, electricians and millwrights is [redacted]/month. The labor rate used for skilled concrete workers and equipment operators is [redacted]/month.

9.4.4 Work Hours

The estimate and schedule are based on subcontractors working 6 - 10 hour work days per week.

9.4.5 Productivity

Craft labor productivity for the turbine work is based on productivity rates for southeastern U.S. adjusted to 50% productivity based on previous experience and the expectation that productivity will be lower due to working in an existing power house facility. Rates for other work are based on U.S. average productivity adjusted to 50% for Afghanistan.

9.4.6 Escalation

Black & Veatch staff salaries, travel and ODC's were escalated 5% per year.

9.4.7 Mobilization/Demobilization

Mobilization and demobilization for construction craft are included in the estimated subcontractor indirects. It was assumed that all craft will be transported to and from site via surface transportation. All Black & Veatch Staff and subcontractor management staff are assumed to be mobilized via helicopter transport and were estimated accordingly. It was assumed for the purpose of the estimate that the road from Kandahar to Kajaki will be open for safe transport of materials for a period to be agreed to prior to the start of construction and throughout the duration of construction.

9.4.8 Material Shipments

All material and equipment shipments, including regular shipments of food and fuel were estimated on the basis of land transportation. It was assumed for the purpose of the estimate that the road from Kandahar to Kajaki will be open for safe transport of materials for a period to be agreed to prior to the start of construction and throughout the duration of construction.

9.4.9 Man-Camp

Man-Camp requirements are based on the construction of a separate subcontractor camp for CLIN 6 subcontractors and the construction of additional facilities and infrastructure required to support Black & Veatch CLIN 6 personnel. The subcontractor camp estimate is based on 120 TCN/CCN and 10 expats. The additional facilities for the BV Camp are required due to expected overlap between CLIN 5 and CLIN 6. It was assumed that all other required upgrades to the existing man-camp will be completed under CLIN 5 prior to field mobilization for CLIN 6. All man-camp facilities will be left in place upon completion of the project.

9.5 Startup and Commissioning

Startup, commissioning and training requirements are included in the Unit 2 subcontractor estimated scope. In addition, Black & Veatch startup personnel and startup consumables are included in the estimate. It was assumed that DABS will provide free access to the entire facility and all equipment, including support of numerous required shutdowns of turbines 1 and 3 and of commissioning activities.

9.6 Project Schedule

The estimate is based on total project duration of 34 months with construction duration of 22 months. The schedule is based on receipt of an NTP by 1 January 2012. Delays in issuance of the NTP could result in increased costs.

9.7 Other Assumptions

- The current amount of security personnel and equipment provided by Black & Veatch is adequate and subcontractors will not need to provide any additional security personnel or equipment.

- Shipping costs are based on current quotes which are contingent on a secure route (secured by the U.S. or other NATO forces) from Kandahar to Kajaki with only standard convoy security escorts required. Any deviation from this assumed condition would result in dramatically increased transport costs and would likely make transport of much of the equipment impossible.

- It was assumed that subcontractors with the skills and experience necessary to do the work are available and willing to work in this location. If the contracting community proves unwilling to work in this area or contractors with the right skills cannot be found in the region, costs will likely significantly increase due to the need to provide extra financial incentives, security or other concessions.

- KHPP has assumed that minimal or no support will be provided by plant personnel with the exception of providing cooperation for access to equipment and accommodation of required outages.

- It was assumed that the U.S. military would remain in place at Kajaki and provide a secure perimeter as is currently the situation. Should this situation change, the estimate would not be valid and it may not be possible to successfully execute the project.

- It was assumed that the security situation at the site will be no worse than the current situation for the duration of the project.

- It was assumed that pricing for security will remain relatively stable for the duration of construction. Should prices for security services increase significantly during the life of the project, the cost of the project would go up accordingly.

- It was assumed that Black & Veatch will be able to continue the use of their current private security contractor for the duration of the project.
- Construction and material escalation will remain level and will not exceed the amount of escalation applied in the estimate. Escalation greater than estimated will result in costs that exceed the current estimate.
- Estimated design effort is based on the following assumptions:
    - All of the original design documents will be provided to Black & Veatch in native CADD format.
    - Black & Veatch will provide design submittals for review at the 50% and 100% milestones.
    - Black & Veatch will not provide detailed rebar fabrication drawings.
    - Black & Veatch will cross check dimensions provided on CMIC or GFE drawings with design drawings. Field checking of dimensions will be done by the Unit 2 subcontractor.

Note: The original Kandahar Helmand Power Project scope for BVSPC included both the hydro plant installation and the new Kajaki substation. The cost estimate for the hydro plant installation presented in this report was based on BVSPC performing both projects. Subsequent to completion of this report, design and construction of the Kajaki substation was assigned to a third party. The scope and schedule of the substation work has not yet been determined. In addition upgrades to the irrigation outlet works by a third party are planned at Kajaki HPP. The cost estimate presented in this report does not address potential cost increases to the hydro plan installation schedule due to third party substation and irrigation outlet works construction activities concurrent with the hydro plant installation on the small, congested Kajaki site.

10.0 HPP COST COMPARISONS

Validation of the Kajaki Unit 2 Hydro estimated construction cost was performed against historical information and energy data available through Government sources. The validation effort used the available information to perform checks by normalizing the data using DoD cost factors evaluating direct construction cost, total capital cost and capacity cost. The DoD cost factors were used to adjust all data provided to compare to a baseline. These calculations and results can be found on Table 10-1. Following are evaluations of the results for each:

Direct construction cost was compared with a similar project currently under construction in Washington State (Lower Baker Project). The Lower Baker project is a complete new plant. All major equipment was Owner furnished similar to GFE at Kajaki and equipment costs were not included in the Kajaki total project cost. The costs for electrical/ mechanical unit installation and associated civil works representing comparable scope to Kajaki Unit 2 were extracted from overall project costs to provide a cost comparison for comparable scope. The indicated Area Cost Factors are based on UFC-3-701-1. When adjusted for area cost factor the estimated direct construction cost for Kajaki Unit 2 is approximately 13% higher than that of the Lower Baker Project. This cost difference is considered to be within a reasonable range and thus validates the estimated Kajaki cost against a known representative cost. Further, the Lower Baker project did not require a man-camp, life support, significant security or the high cost of material transport required for Kajaki Unit 2. Given these factors, the estimated total adjusted cost of Kajaki Unit 2 is reasonable when compared with the Lower Baker project.

Total project cost for Kajaki Unit 2 was compared with historical costs from a project in Snettisham, Alaska. After adjustment for area cost factor and escalation (Snettisham project completed in 1991) the Kajaki Unit 2 estimated cost was [redacted] less than the Snettisham. The Snettisham project included more scope in the actual power plant but was on a Greenfield site and did not require a man-camp or the security costs associated with Kajaki Unit 2. These scope differences are offsetting and thus the adjusted cost is considered to be comparative. Based on these factors, the estimated cost of Unit 2 appears to be reasonable.

A comparison was also made between Kajaki Unit 2 estimated total cost and Department of Energy (DOE) historical cost/KW. The estimated cost per KW is within reason when compared to the range of DOE historical costs adjusted to 2011 $. It exceeds the high end of the DOE range but none of the DOE domestic projects would have required the level of security, life support and logistics costs that will be required at Kajaki.

In conclusion, these comparison costs validate the estimated costs determined for Kajaki Unit 2. Because of the unique circumstances related to Kajaki Unit 2, it is not possible to have an exact comparison but it does provide some level of assurance that the estimated costs are within reason.

Table 10 – 1

Comparison of Kajaki Unit 2 Estimated Costs with Historical Hydroelectric Project Construction Data				
Hydroturbine Direct Construction Cost Comparison				
Project	**Location**	**Total Direct Costs**	**DoD Area Cost Factor**	**Adjusted Total Direct Costs**
Kajaki Unit 2 Estimated Direct Construction (Labor, Equipment and Commodities)	Kajaki, Afghanistan	[redacted]	1.63	[redacted]
Lower Baker Project Direct Construction (Labor, Equipment and Commodities)	Washington State, USA	[redacted]	1.02	[redacted]
Total Capital Cost Project Comparison				
Project	**Location**	**Total Cost (2011 $)**	**DoD Area Cost Factor**	**Adjusted Total Capital Costs**
Kajaki Unit 2 Estimate (Includes all costs including Camp and Life Support)	Kajaki, Afghanistan	[redacted]	1.63	[redacted]
Lower Baker total Construction Cost	Washington State, USA	[redacted]	1.02	[redacted]
Snettisham Alaska Plant	Snettisham, Alaska	[redacted]	1.67	[redacted]
Comparison with Dept. of Energy Cost/KW Data	**Location**	**Total Cost/KW (2011 $)**	**DoD Area Cost Factor**	**Adjusted Capital Costs/KW**
Kajaki Unit 2 Estimated	Kajaki, Afghanistan	[redacted]	1.63	[redacted]
DOE Cost/KW Low End of Range - Domestic Projects	U.S.	[redacted]	1	[redacted]
DOE Cost/KW High End of Range - Domestic Projects	U.S.	[redacted]	1	[redacted]